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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XV.—NO. 354.

THE DIRECTORATE OF ELECTRIC LIGHTING COMPANIES.

EACH succeeding shareholders' meeting of the greater number of remaining electric lighting companies brings with it still further revelations of the fruitless—worse than fruitless—nature of the undertakings embarked upon with so much enthusiasm little more than two years ago. At that period companies were incorporated one after another with a rapidity really remarkable, and investors vied with each other in obtaining shares in any concern which, upon pretexts however slight, claimed to be able to light by electricity. Almost immediate and phenomenally profitable returns were anticipated, but with a confidence begotten only of blindly avaricious desire for large realisations upon proportionally small investments, and not induced by calm and judicious consideration of the possibilities of the new illuminating agency. That the result has been vastly different to the roseate expectations of these sanguine investors is now notorious. Company after company has acknowledged its inability to carry on operations with any chance of a profit, and has succumbed to liquidation at the instance of its creditors, or has voluntarily wound up its own affairs, until at the present time the commercially sound electric lighting bodies may almost be counted upon the fingers of one hand.

The latest to display to the public its want of success is the company whose general meeting was reported in our last issue, the Pilsen-Joel and General Electric Light Company. Starting with exceptionally good prospects, and possessing patents whose value was indisputable, it was not unreasonable to prognosticate a fair and prosperous future for this enterprise; but, it seems, there were elements in its composition which would not admit of such a gratifying eventuality, and what these were we think we can in some degree indicate. Without a doubt the provisions of the Electric Lighting Bill, introduced by a Government anxious to keep the new industry, the nature of which was but imperfectly understood, well within manageable limits, has contributed materially to the present condition of this as well as of other similar companies; but it is our decided impression that the main responsibility rests with the directors much more generally than is usually admitted. In the majority of cases the boards of these companies have been composed of from five to eight directors of doubtful commercial abilities, and of no technical knowledge whatever. To expect successful working under such circumstances is little short of absurd. It may be that occasionally, in some branches of industry, a concern is satisfactorily conducted by means of strict application and ordinary business capacity without any great degree of owledge of a special and technical character; but such cases are rare, and not applicable to undertakings such as we have under notice. A thorough acquaintance with the principles of the science which governs the form of lighting which occupies our attention, and with the method of their practical application, is essential on the part of at least one member of a directorate. To the fact that this necessity has been ignored may be attributed the collapse of so many electric lighting companies. Where there *has* been a combination of technical and commercial knowledge the result has been eminently satisfactory, and to prove this we need only mention the firms of Messrs. Siemens Brothers, Messrs. Crompton & Co., and the Anglo-American Brush Corporation as instances.

It would naturally be imagined that if the directors themselves have not the requisite special knowledge, they would at least consult their engineers where questions relating more to technical matters than to commercial administration were involved, and pay some heed to their views; but too often it is otherwise, and the directors of electric lighting companies have much to answer for in that they have persistently ignored the advice of those best calculated to intelligently offer it, thereby bringing about those disastrous results which they deplore, at the same time assigning them to any but the right causes. It seemed from the tone of the remarks made by Sir Rawson W. Rawson at the meeting of the Pilsen-Joel Company last week, that he has not yet recognised that in order to successfully conduct an electrical business something more than the "practical judgment and sound economical administration" of which he spoke, and which are all very well and useful in their place, is required; at any rate, whether he has or not, we trust that the shareholders have, and that they will demonstrate the fact.

Indirectly priding himself as he did upon the possession of practical judgment—another name, we imagine, for common sense—we should like to learn in what manner the Chairman of the Pilsen-Joel Company thinks he exercised the quality in his policy regarding the sale of the Pilsen arc lamps. Was it not a suicidal process to refuse to sell these because they were to be employed in connection with machines other than those manufactured by his own company? What could it possibly matter to the directors how they were to be used, so long as they disposed of the lamps at a good profit? Would they have refused an order for Schuckert dynamos because they were required to work Brush lamps?

We are firmly of opinion that any electric lighting company might be well and easily directed by a board numbering three only; two commercial men, and the third technical. If these were to give their undivided attention to the particular business in which they were engaged, not accepting seats on other boards with the result that they would be able to bestow but little time of real value to any one of the concerns, they would achieve much greater prosperity than is now observable in the majority of instances.

A further meeting of the Pilsen-Joel Company is to be held on the 12th inst., for the purpose, amongst other things, of electing a fourth director, and if the shareholders esteem our advice at all, they will on that day insist upon the inclusion in the new board of some one possessing the advantage of technical knowledge in addition to administrative ability, for by that means alone, it seems to us, is there a hopeful possibility of saving what are really most valuable patents from falling to the ground.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—MONTREAL, 1884.

SECTION A.

Mathematical and Physical Science.

Opening Address by Prof. Sir William Thomson, M.A., LL.D., D.C.L., F.R.SS.L. & E., F.R.A.S., President of the Section.

STEPS TOWARDS A KINETIC THEORY OF MATTER.

The now well-known kinetic theory of gases is a step so important in the way of explaining seemingly static properties of matter by motion, that it is scarcely possible to help anticipating in idea the arrival at a complete theory of matter, in which all its properties will be seen to be merely attributes of motion. If we are to look for the origin of this idea we must go back to Democritus, Epicurus, and Lucretius. We may then, I believe, without missing a single step, skip 1,800 years. Early last century we find in Malebranche's "Recherche de la Verité" the statement that "La dureté de corps" depends on "petits tourbillons."[*] These words, embedded in a hopeless mass of unintelligible statements of the physical, metaphysical, and theological philosophies of the day, and unsupported by any explanation, elucidation, or illustration throughout the rest of the three volumes, and only marred by any other single sentence or word to be found in the great book, still do express a distinct conception, which forms a most remarkable step towards the kinetic theory of matter. A little later we have Daniel Bernoulli's promulgation of what we now accept as a surest article of scientific faith—the kinetic theory of gases. He, so far as I know, thought only of the Boyle's and Marriot's law of the "spring of air," as Boyle called it, without reference to change of temperature or the augmentation of its pressure if not allowed to expand for elevation of temperature, a phenomenon which, perhaps, he scarcely knew, still less the elevation of temperature produced by compression, and the lowering of temperature by dilatation, and the consequent necessity of waiting for a fraction of a second or a few seconds of time (with apparatus of ordinary experimental magnitude), to see a subsidence from a larger change of pressure, down to the amount of change that verifies Boyle's law. The consideration of these phenomena 40 years ago by Joule, in connection with Bernoulli's original conception, formed the foundation of the kinetic theory of gases as we now have it. But what a splendid and useful building has been placed on this foundation by Clausius and Maxwell, and what a beautiful ornament we see on the top of it in the radiometer of Crookes, securely attached to it by the happy discovery of Tait and Dewar,[†] that the length of the free path of the residual molecules of air in a good modern vacuum may amount to several inches. Clausius's and Maxwell's explanations of the diffusion of gases, and of thermal conduction in gases, their charmingly intelligible conclusion that in gases the diffusion of heat is just a little more rapid than the diffusion of molecules, because of the interchange of energy in collisions between molecules,[‡] while the chief transference of heat is by actual transport of the molecules themselves, and Maxwell's explanation of the viscosity of gases, with the absolute numerical relations which the work of those two great discoverers found among the three properties of diffusion, thermal conduction, and viscosity, have annexed to the domain of science a vast and ever-growing province.

Rich as it is in practical results, the kinetic theory of gases, as hitherto developed, stops absolutely short at the atom or molecule, and gives not even a suggestion towards explaining the properties in virtue of which the atoms or molecules mutually influence one another. For some guidance towards a deeper and more comprehensive theory of matter, we may look back with advantage to the end of last century, and the beginning of this century, and find Rumford's conclusion regarding the heat generated in boring a brass gun: "It appears to me to be extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in these experiments, except it be motion," and Davy's still more suggestive statements: "The phenomena of repulsion are not dependent on a peculiar elastic fluid for their existence. . . ." "Heat may be defined as a peculiar motion, probably a vibration, of the corpuscles of bodies, tending to separate them. . . ." "To distinguish this motion from others, and to signify the causes of our sensations of heat, &c., the name *repulsive* motion has been adopted." Here we have a most important idea. It would be somewhat a bold figure of speech to say the earth and moon are kept apart by a repulsive motion; and yet, after all, what is centrifugal force but a repulsive motion, and may it not be that there is no such thing as repulsion, and that it is solely by inertia that what seems to be repulsion is produced? Two bodies fly together, and, accelerated by mutual attraction, if they do not precisely hit one another, they cannot but separate in virtue of the inertia of their masses. So, after dashing past one another in sharply concave curves round their common centre of gravity, they fly asunder again. A careless onlooker might imagine they had repelled one another, and might not notice the difference between what he actually sees and what he would see if the two bodies had been projected with great velocity towards one another, and either colliding and rebounding, or repelling one another into sharply convex continuous curves, fly asunder again.

Joule, Clausius, and Maxwell, and no doubt Daniel Bernoulli himself, and I believe every one who has hitherto written or done anything very explicit in the kinetic theory of gases, has taken the mutual action of molecules in collision as repulsive. May it not after all be attractive? This idea has never left my mind since I first read Davy's "Repulsive Motion," about thirty-five years ago, but I never made anything of it, at all events have not done so until to-day (June 16, 1884)—if this can be said to be making anything of it—when, in endeavouring to prepare the present address, I notice that Joule's and my own old experiments[*] on the thermal effect of gases expanding from a high-pressure vessel through a porous plug, proves the less dense gas to have greater intrinsic *potential* energy than the denser gas, if we assume the ordinary hypothesis regarding the temperature of a gas, according to which two gases are of equal temperatures[†] when the kinetic energies of their constituent molecules are of equal average amounts per molecule.

Think of the thing thus. Imagine a great multitude of particles inclosed by a boundary which may be pushed inwards in any part all round at pleasure. Now station an engineer corps of Maxwell's army of sorting demons all round the inclosure, with orders to push in the boundary diligently everywhere, when none of the besieged troops are near, and to do nothing when any of them are seen approaching, and until after they have turned again inwards. The result will be that, with exactly the same sum of kinetic and potential energies of the same inclosed multitude of particles, the throng has been caused to be denser. Now Joule's and my own old experiments on the efflux of air prove that if the crowd be common air, or oxygen, or nitrogen, or carbonic acid, the temperature is a little higher in the denser than in the rarer condition when the energies are the same. By the hypothesis, equality of temperature between two different gases or two portions of the same gas at different densities means equality of kinetic energies in the same number of molecules of the two. From our observations proving the temperature to be higher, it therefore follows that the potential energy is smaller in the condensed crowd. This—always, however, under protest as to the temperature hypothesis—proves some degree of attraction among the molecules, but it does not prove ultimate attraction between two molecules in collision, or at distances much less than the average mutual distance of nearest neighbours in the multitude. The collisional force might be repulsive, as generally supposed hitherto, and yet attraction might predominate in the whole reckoning of difference between the intrinsic potential energies of the more dense and less dense multitudes. It is, however, remarkable that the explanation of the propagation of sound through gases, and even of the positive fluid pressure of a gas against the sides of the containing vessel, according to the kinetic theory of gases, is quite independent of the question whether the ultimate collisional force is attractive or repulsive. Of course it must be understood that, if it is attractive, the particles must be so small that they hardly ever meet—they would have to be infinitely small to *never* meet—that, in fact, they meet so seldom, in comparison with the number of times their courses are turned through large angles by attraction, that the influence of these purely attractive collisions is preponderant over that of the comparatively very rare impacts from actual contact. Thus, after all, the train of speculation suggested by Davy's "Repulsive Motion" does not allow us to escape from the idea of true repulsion, does not do more than let us say it is of no consequence, nor even say this with truth, because, if there are impacts at all, the nature of the force during the impact and the effects of the mutual impacts, however rare, cannot be evaded in any attempt to realise a conception of the kinetic theory of gases. And in fact, unless we are satisfied to imagine the atoms of a gas as mathematical points endowed with inertia, and, as according to Boscovich, endowed with forces of mutual positive and negative attraction, varying according to some definite function of the distance, we cannot avoid the question of impacts, and of vibrations and rotations of the molecules resulting from impacts, and we must look distinctly on each molecule as being either a little elastic solid or a configuration of motion in a continuous all-pervading liquid. I do not myself see how we can ever permanently rest anywhere short of this last view; but it would be a very pleasant temporary resting-place on the way to it if we could, as it were, make a mechanical model of a gas out of little pieces of round perfectly elastic solid matter, flying about through the space occupied by the gas, and colliding with one another and against the sides of the containing vessel. This is, in fact, all we have of the kinetic theory of gases up to the present time, and this has done for us, in the hands of Clausius and Maxwell, the great things which constitute our first step towards a molecular theory of matter. Of course from it we should have to go on to find an explanation of the elasticity and all the other properties of the molecules themselves, a subject vastly more complex and difficult than the gaseous properties, for the explanation of which we assume the elastic molecule; but without any explanation of the properties of the molecule itself, with merely the assumption that the molecule has the requisite properties, we might rest happy for a while in the contemplation of the kinetic theory of gases, and its explanation of the gaseous properties, which is not only stupendously important as a step towards a more thorough-going theory of matter, but is undoubtedly the expression of a perfectly intelligible and definite set of facts in nature. But, alas for our mechanical model consisting of the cloud of little elastic solids flying about amongst one another. Though each particle have absolutely perfect elasticity, the end must be pretty much the same as if it were but imperfectly elastic. The average effect of repeated and repeated mutual collisions must be to gradually convert all the translational energy into energy of shriller and shriller vibrations of the molecule. It seems certain that each collision must have something more of energy in vibrations of very finely divided nodal parts than there was of energy in such vibrations before the impact. The more minute this nodal subdivision, the less must be the tendency to give up part of the vibrational energy into the shape of translational energy in the course of a collision, and I think it is rigorously demonstrable that the whole translational energy must ultimately become transformed into vibrational energy of higher and higher nodal subdivisions if each molecule is a continuous elastic solid. Let us, then, leave the kinetic theory of gases for a time with this difficulty unsolved, in the hope that we or others after us may return to it armed with more knowledge of the properties of matter, and with sharper mathematical weapons to cut through the barrier which at present hides from us any view of the molecule itself, and of the effects other than mere change of translational motion which it experiences in collision.

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[*] "Preuve de la supposition que j'ay faite: Que la matière subtile ou éthérée est nécessairement composée de PETITS TOURBILLONS; et qu'ils sont les causes naturelles de tous les changements qui arrivent à la matière; ce que je confirme par l'explication des effets le plus généraux de la Physique, tels que sont la dureté des corps, leur fluidité, leur pesanteur, leur légèreté, la lumière et la réfraction et réflexion de ses rayons."—Malebranche, "Recherche de la Vérité," 1712.

[†] *Proc.* R. S. E., March 2, 1874, and July 5, 1875.

[‡] On the other hand, in liquids, on account of the crowdedness of the molecules, the diffusion of heat must be chiefly by interchange of energies between the molecules, and should be, as experiment proves it is, enormously more rapid than the diffusion of the molecules themselves, and this again ought to be much less rapid than either the material or thermal diffusivities of gases. Thus the diffusivity of common salt through water was found by Fick to be as small as ·0000112 square centimetres per second; nearly 200 times as great as this is the diffusivity of heat through water, which was found by J. T. Bottomley to be about ·002 square centimetres per second. The material diffusivities of gases, according to Loschmidt's experiments, range from ·098 (the interdiffusivity of carbonic acid and nitrous oxide) to ·642 (the interdiffusivity of carbonic oxide and hydrogen), while the thermal diffusivities of gases, calculated according to Clausius's and Maxwell's kinetic theory of gases, are ·089 for carbonic acid, ·16 for common air or other gases of nearly the same density, and 1·12 for hydrogen (all, both material and thermal, being reckoned in square centimetres per second).

[*] Republished in Sir W. Thomson's "Mathematical and Physical Papers," vol. i., Article xlix., p. 381.

[†] That this is a mere hypothesis has been scarcely remarked by the founders themselves, nor by almost any writer on the kinetic theory of gases. No one has yet examined the question: What is the condition as regards average distribution of kinetic energy, which is ultimately fulfilled by two portions of gaseous matter, separated by a thin elastic septum which absolutely prevents interdiffusion of matter, while it allows interchange of kinetic energy by collisions against itself? Indeed I do not know but that the present is the very first statement which has ever been published of this condition of the problem of equal temperatures between two gaseous masses.

To explain the elasticity of a gas was the primary object of the kinetic theory of gases. This object is only attainable by the assumption of an elasticity more complex in character, and more difficult of explanation, than the elasticity of gases—the elasticity of a solid. Thus, even if the fatal fault in the theory, to which I have alluded, did not exist, and if we could be perfectly satisfied with the kinetic theory of gases founded on the collisions of elastic solid molecules, there would still be beyond it a grander theory which need not be considered a chimerical object of scientific ambition—to explain the elasticity of solids. But we may be stopped when we commence to look in the direction of such a theory with the cynical question: What do you mean by explaining a property of matter? As to being stopped by any such question, all I can say is that if engineering were to be all and to end all physical science, we should perforce be content with merely finding properties of matter by observation, and using them for practical purposes. But I am sure very few, if any, engineers are practically satisfied with so narrow a view of their noble profession. They must and do patiently observe, and discover by observation, properties of matter and results of material combinations. But deeper questions are always present, and always fraught with interest to the true engineer, and he will be the last to give weight to any other objection to any attempt to see below the surface of things than the practical question—Is it likely to prove wholly futile? But now, instead of imagining the question: What do you mean by explaining a property of matter? to be put cynically, and letting ourselves be irritated by it, suppose we give to the questioner credit for being sympathetic, and condescend to try and answer his question. We find it not very easy to do so. All the properties of matter are so connected that we can scarcely imagine one *thoroughly explained* without our seeing its relation to all the others, without in fact having the explanation of all, and till we have this we cannot tell what we mean by "explaining a property" or "explaining the properties" of matter. But though this consummation may never be reached by man, the progress of science may be, I believe will be, step by step towards it, on many different roads converging towards it from all sides. The kinetic theory of gases is, as I have said, a true step on one of the roads. On the very distinct road of chemical science St. Clair Deville arrived at his grand theory of dissociation without the slightest aid from the kinetic theory of gases. The fact that he worked it out solely from chemical observation and experiment, and expounded it to the world without any hypothesis whatever, and seemingly even without consciousness of the beautiful explanation it has in the kinetic theory of gases, secured for it immediately an independent solidity and importance as a chemical theory when he first promulgated it, to which it might even by this time scarcely have attained if it had first been suggested as a probability indicated by the kinetic theory of gases, and been only afterwards confirmed by observation. Now, however, guided by the views which Clausius and Williamson have given us of the continuous interchange of partners between the compound molecules constituting chemical compounds in the gaseous state, we see in Deville's theory of dissociation a point of contact of the most transcendent interest between the chemical and physical lines of scientific progress.

To return to elasticity: if we could make out of matter devoid of elasticity a combined system of relatively moving parts which, in virtue of motion, has the essential characteristics of an elastic body, this would surely be, if not positively a step in the kinetic theory of matter, at least a finger-post pointing a way which we may hope will lead to a kinetic theory of matter. Now this, as I have already shown,* we can do in several ways. In the case of the last of the communications referred to, of which only the title has hitherto been published, I showed that from the mathematical investigation of a gyrostatically dominated combination contained in the passage of Thomson and Tait's "Natural Philosophy" referred to, it follows that any ideal system of material particles, acting on one another mutually through massless connecting springs, may be perfectly imitated in a model consisting of rigid links jointed together, and having rapidly rotating fly-wheels pivoted on some or on all of the links. The imitation is not confined to cases of equilibrium. It holds also for vibration produced by disturbing the system infinitesimally from a position of stable equilibrium and leaving it to itself. Thus we may make a gyrostatic system such that it is in equilibrium under the influence of certain positive forces applied to different points of this system; all the forces being precisely the same as, and the points of application similarly situated to, those of the stable system with springs. Then, provided proper masses (that is to say, proper amounts and distributions of inertia) be attributed to the links, we may remove the external forces from each system, and the consequent vibration of the points of application of the forces will be identical. Or we may act upon the systems of material points and springs with any given forces for any given time, and leave it to itself, and do the same thing for the gyrostatic system; the consequent motion will be the same in the two cases. If in the one case the springs are made more and more stiff, and in the other case the angular velocities of the fly-wheels are made greater and greater, the periods of the vibrational constituents of the motion will become shorter and shorter, and the amplitudes smaller and smaller, and the motions will approach more and more nearly those of two perfectly rigid groups of material points, moving through space and rotating according to the well-known mode of rotation of a rigid body having unequal moments of inertia about its three principal axes. In one case the ideal nearly rigid connection between the particles is produced by massless exceedingly stiff springs; in the other case it is produced by the exceedingly rapid rotation of the fly-wheels in a system which, when the fly-wheels are deprived of their rotation, is perfectly limp.

The drawings (figs. 1 and 2) before you illustrate two such material systems.† The directions of rotation of the fly-wheels in the gyrostatic system (fig. 2) are indicated by directional ellipses, which show in perspective the direction of rotation of the fly-wheel of each gyrostat. The gyrostatic system (fig. 2) might have been constituted of two gyrostatic members, but four are shown for symmetry. The inclosing circle represents in each case in section an inclosing spherical shell to prevent the interior from being seen. In the inside of one there are fly-wheels, in the inside of the other a massless spring. The projecting hooked rods seem as if they are connected by a spring in each case. If we hang any one of the systems up by the hook on one of its projecting rods, and hang a weight to the hook of the other projecting rod, the weight, when first put on, will oscillate up and down, and will go on doing so for ever if the system be absolutely unfrictional. If we check the vibration by hand, the weight will hang down at rest, the pin drawn out to a certain degree; and the distance drawn out will be simply proportional to the weight hung on, as in an ordinary spring balance.

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* Paper on "Vortex Atoms," *Proc.* R. S. E., February, 1867; abstract of a lecture before the Royal Institution of Great Britain, March 4, 1881, on "Elasticity viewed as possibly a mode of motion;" Thomson and Tait's "Natural Philosophy," second edition, part 1, §§ 345 viii. to 345 xxvii.; "On Oscillation and Waves in an Adynamic Gyrostatic System" (title only), *Proc.* R. S. E., March, 1883.

† In fig. 1 the two hooked rods seen projecting from the sphere are connected by an elastic coach-spring. In fig. 2 the hooked rods are connected one to each of two opposite corners of a four-sided jointed frame, each member of which carries a gyrostat so that the axis of rotation of the fly-wheel is in the axis of the member of the frame which bears it. Each of the hooked rods in fig. 2 is connected to the framework through a swivel joint, so that the whole gyrostatic framework may be rotated about the axis of the hooked rods in order to annul the moment of momentum of the framework about this axis due to rotation of the fly-wheels in the gyrostat.

Here, then, out of matter possessing rigidity, but absolutely devoid of elasticity, we have made a perfect model of a spring in the form of a spring balance. Connect millions of millions of particles by pairs of rods such as these of this spring balance, and we have a group of particles constituting an elastic solid; exactly fulfilling the mathematical ideal worked out by Navier, Poisson, and Cauchy, and many other mathematicians who, following their example, have endeavoured to found a theory of the elasticity of solids on mutual attraction and repulsion between a group of material particles. All that can possibly be done by this theory, with its assumption of forces acting according to any assumed law of relation to distance, *is* done by the gyrostatic system. But the gyrostatic system does, besides, what the system of naturally acting material particles cannot do; it constitutes an elastic solid which can have the Faraday magneto-optic rotation of the plane of polarisation of light; supposing the application of our solid to be a model of the luminiferous ether for illustrating the undulatory theory of light. The gyrostatic model spring balance is arranged to have zero moment of momentum as a whole, and therefore to contribute nothing to the Faraday rotation; with this arrangement the model illustrates the luminiferous ether in a field unaffected by magnetic force. But now let there be a different rotational velocity imparted to the jointed square round the axis of the two projecting hooked rods, such as to give a resultant moment of momentum round any given line through the centre of inertia of the system, and let pairs of the hooked rods in the model thus altered, which is no longer a model of a mere spring balance, be applied as connections between millions of pairs of particles as before; with the lines of resultant moment of momentum all similarly directed. We now have a model elastic solid which will have the property that the direction of vibration in waves of rectilinear vibrations propagated through it shall turn round the line of propagation of the waves, just as Faraday's observation proves to be done by the line of vibration of light in a dense medium between the poles of a powerful magnet. The case of wave front perpendicular to the lines of resultant moment of momentum (that is to say, the direction of propagation being parallel to these lines) corresponds, in our mechanical model, to the case of light travelling in the direction of the lines of force in a magnetic field.

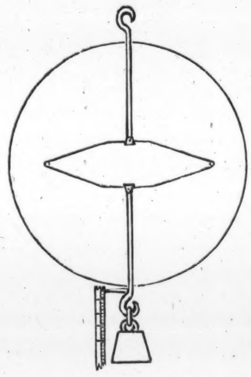

FIG. 1.

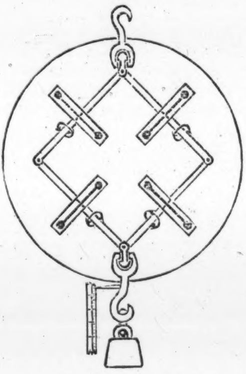

FIG. 2.

In these illustrations and models we have different portions of ideal rigid matter acting upon one another, by normal pressure at mathematical points of contact—of course no forces of friction are supposed. It is exceedingly interesting to see how thus, with no other postulates than inertia, rigidity, and mutual impenetrability, we can thoroughly model not only an elastic solid, and any combination of elastic solids, but so complex and recondite a phenomenon as the passage of polarised light through a magnetic field. But now, with the view of ultimately discarding the postulate of rigidity from all our materials, let us suppose some to be absolutely destitute of rigidity, and to possess merely inertia and incompressibility, and mutual impenetrability with reference to the still remaining rigid matter. With these postulates we can produce a perfect model of mutual action at a distance between solid particles, fulfilling the condition, so keenly desired by Newton and Faraday, of being explained by continuous action through an intervening medium. The law of the mutual force in our model, however, is not the simple Newtonian law, but the much more complex law of the mutual action between electro-magnets—with this difference, that in the hydrokinetic model in every case the force is opposite in direction to the corresponding force in the electro-magnetic analogue. Imagine a solid bored through with a hole and placed in our ideal perfect liquid. For a moment let the hole be stopped by a diaphragm, and let an impulsive pressure be applied for an instant uniformly over the whole membrane, and then instantly let the membrane be dissolved into liquid. This action originates a motion of the liquid relatively to the solid, of a kind to which I have given the name of "irrotational circulation," which remains absolutely constant however the solid be moved through the liquid. Thus, at any time the actual motion of the liquid at any point in the neighbourhood of the solid will be the resultant of the motion it would have in virtue of the circulation alone, were the solid at rest, and the motion it would have in virtue of the motion of the solid itself, had there been no circulation established through the aperture. It is interesting and important to remark in passing that the whole kinetic energy of the liquid is the sum of the kinetic energies which it would have in the two cases separately. Now, imagine the whole liquid to be inclosed in an infinitely large, rigid, containing vessel, and in the liquid, at an infinite distance from any part of the containing vessel, let two perforated solids, with irrotational circulation through each, be placed at rest near one another. The resultant fluid motion due to the two circulations will give rise to fluid pressure on the two bodies, which, if unbalanced, will cause them to move. The force systems—force-and-torques, or pairs of forces—required to prevent them from moving will be mutual and opposite, and will be the same as, but opposite in direction to, the mutual force systems required to hold at rest two electro-magnets fulfilling the following specification. The two electro-magnets are to be of the same shape and size as the two bodies, and to be placed in the same relative positions, and to consist of infinitely thin layers of electric currents in the surfaces of solids possessing extreme diamagnetic quality—in other words, infinitely small permeability. The distribution of electric current on each body may be any whatever which fulfils the condition that the total current across any closed line drawn on the surface once through the aperture is equal to $\frac{\pi}{4}$ of the circulation * through the aperture in the hydro-kinetic analogue.

It might be imagined that the action at a distance thus provided for by fluid motion could serve as a foundation for a theory of the equilibrium, and the vibrations, of elastic solids, and the transmission of waves like those of light through an extended quasi-elastic solid medium. But unfortunately for this idea the equilibrium is essentially unstable, both in the case of magnets, and, notwithstanding the fact that the forces are oppositely directed, in the hydro-kinetic analogue also, when the several movable bodies (two or any greater number) are so placed relatively as to be in equilibrium. If, however, we connect the perforated bodies with circulation through them in the hydro-kinetic system, by jointed rigid connecting links, we may arrange for configurations of stable equilibrium. Thus without fly-wheels, but with fluid circulations through apertures, we may make a model spring balance, or a model luminiferous ether, either without or with the rotational quality corresponding to that of the true luminiferous ether in the magnetic fluid—in short, do all by the perforated solids with circulations through them that we saw we could do by means of linked gyrostats. But something that we cannot do by linked gyrostats we can do by the perforated bodies with fluid circulation: we can make a model gas. The mutual action at a distance, repulsive or attractive according to the mutual aspect of the two bodies when passing within collisional distance† of one another, suffices to produce the change of direction of motion in collision, which essentially constitutes the foundation of the kinetic theory of gases, and which, as we have seen before, may as well be due to attraction as to repulsion, so far as we know from any investigation hitherto made in this theory.

There remains, however, as we have seen before, the difficulty of providing for the case of actual impacts between the solids, which must be done by giving them massless spring buffers, or, which amounts to the same thing, attributing to them repulsive forces sufficiently powerful at very short distances to absolutely prevent impacts between solid and solid; unless we adopt the equally repugnant idea of infinitely small perforated solids, with infinitely great fluid circulations through them. Were it not for this fundamental difficulty, the hydro-kinetic model gas would be exceedingly interesting; and, though we could scarcely adopt it as conceivably a true representation of what gases really are, it might still have some importance as a model configuration of solid and liquid matter, by which without elasticity the elasticity of a true gas might be represented.

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* The integral of tangential component velocity all round any closed curve, passing once through the aperture, is defined as the "cyclic constant," or the "circulation" ("Vortex Motion," § 60 (*a*), *Trans.* R. S. E. April 29, 1867). It has the same value for all closed curves passing just once through the aperture, and it remains constant through all time, whether the solid body be in motion or at rest.

† According to this view there is no precise distance, or definite condition respecting the distance, between two molecules, at which apparently they come to be in collision, or when receding from one another they cease to be in collision. It is convenient, however, in the kinetic theory of gases, to adopt arbitrarily a precise definition of collision, according to which two bodies or particles mutually acting at a distance may be said to be in collision when their mutual action exceeds some definite arbitrarily assigned limit, as, for example, when the radius of curvature of the path of either body is less than a stated fraction ($\frac{1}{100}$th, for instance) of the distance between them.

But lastly, since the hydro-kinetic model gas with perforated solids and fluid circulations through them fails because of the impacts between the solids, let us annul the solids and leave the liquid performing irrotational circulation round vacancy,[*] in the place of the solid cores which we have hitherto supposed; or let us annul the rigidity of the solid cores of the rings and give them molecular rotation according to Helmholtz's theory of vortex motion. For stability the molecular rotation must be such as to give the same velocity at the boundary of the rotational fluid core as that of the irrotationally circulating liquid in contact with it, because, as I have proved, frictional slip between two portions of liquid in contact is inconsistent with stability. There is a further condition, upon which I cannot enter into detail just now, but which may be understood in a general way when I say that it is a condition of either uniform or of increasing molecular rotation from the surface inwards, analogous to the condition that the density of a liquid, resting for example under the influence of gravity, must either be uniform or must be greater below than above for stability of equilibrium. All that I have said in favour of the model vortex gas composed of perforated solids with fluid circulations through them holds without modification for the purely hydro-kinetic model, composed of either Helmholtz cored vortex-rings or of coreless vortices, and we are now troubled with no such difficulty as that of the impacts between solids. Whether, however, when the vortex theory of gases is thoroughly worked out, it will or will not be found to fail in a manner analogous to the failure which I have already pointed out in connection with the kinetic theory of gases composed of little elastic solid molecules, I cannot at present undertake to speak with certainty. It seems to me most probable that the vortex theory cannot fail in such way, because all I have been able to find out hitherto regarding the vibration of vortices,[†] whether cored or coreless, does not seem to imply the liability of translational or impulsive energies of the individual vortices becoming lost in energy of smaller and smaller vibrations.

As a step towards kinetic theory of matter it is certainly most interesting to remark that in the quasi-elasticity, elasticity looking like that of an India rubber band, which we see in a vibrating smoke-ring launched from an elliptic aperture, or in two smoke-rings which were circular, but which have become deformed from circularity by mutual collision, we have in reality a virtual elasticity in matter devoid of elasticity, and even devoid of rigidity, the virtual elasticity being due to motion, and generated by the generation of motion.

ELECTRIC LIGHT CONDUCTORS.

IN the REVIEW for March 29th of the present year we published a short article on an invention, credited to Dr. J. Hopkinson, by means of which the cost of conductors was greatly reduced.

Mr. Edison also thought of the same plan, simultaneously it is said with Dr. Hopkinson, and we notice in the last number of the New York *Electrical Review* a description of Mr. Edison's method of employing this device.

Our contemporary, in speaking of the improvements made from time to time in the Edison system of electric lighting, says:—

"But by far the greatest advance was made when the coupling of two machines in series utilised their combined electromotive force, and doubled the available quantity delivered over a given pair of wires at any point on the system, while the attachment of a third wire to the link connecting the two dynamos made it possible to use in any one building, or apartment, the force of only one generator. This peculiar arrangement, and its contrast with the old two-wire principle, is made plain by figs. 1 and 2. In the first we recognise the familiar idea of two parallel conductors connected with the dynamo, A, and lamps in multiple arc on the main wires at *a* and *b*, and in any illuminated space, *c*. Here we conceive of the outgoing current, as traversing the positive main and all its connecting branches to the lamps, and returning after doing its work to the negative terminal of the dynamo. In such a system, of course, the greatest difference of potential to be considered is that existing at the brushes, and in central station work usually amounts to an E.M.F. of 115 to 130 volts, according to the loss anticipated by the calculated resistance of the conductors, and the resistance of the lamps to be used. The Edison central stations, where the loss in distribution, when the system is taxed to its ultimate capacity, is from ten to twenty per cent., are usually supplied with lamps requiring in different cases from 105 to 110 volts, and the economy of their use is thus made equal to that of isolated plants where the drop in potential from dynamo to lamps seldom exceeds five per cent., and where the lamps may be from 90 to 100 volts. It will also be readily understood by many readers that the great number of lamps likely to be attached to a central station system, and the consequent lowering of the aggregate resistance of the outside circuit with respect to the internal resistance of the dynamo, makes it very desirable that the individual lamps shall be of as high resistance as possible, that the total external resistance may be kept comparatively large.

"That none may be left in doubt as to this all-important point, suppose the dynamo in fig. 1 to be of the type known as "H," capable of carrying 450 16-candle lamps, and that each of the circles at *a*, *b*, *c* and *d* represents a group of fifty such lamps. Before connecting any lights we have, if our insulation be perfect, an infinite resistance between the conductors, and (disregarding that of the field-magnets) perhaps 0·01 ohms in the dynamo. Now connecting one lamp, 150 ohms, and throwing out the resistance of the conductors, we have 0·01 : 150, or only $\frac{1}{15000}$ the resistance of the whole circuit in the machine, leaving all but a minute fraction of the energy developed by the armature to be expended as useful work in the lamp. At this stage of the experiment the resistance of the lamp circuit is at its highest point, and we secure the extreme of theoretical efficiency. Now turn on all of the 450 lights; their joint resistance is only one-third of one ohm (0·33), and so long as the coils of the armature remain cool, the ratio will stand 0·01 : 0·33, indicating that $\frac{32}{33}$ of the current is doing commercial work. Having now arrived at the normal capacity of the generator, if the number of lamps be still further increased, a second dynamo must be connected in multiple with the first, that the armatures may jointly give a sufficiently low internal resistance, and the E.M.F. be kept up at the lamps. The method of doing this will be described farther on.

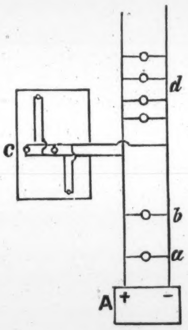

FIG. 1.

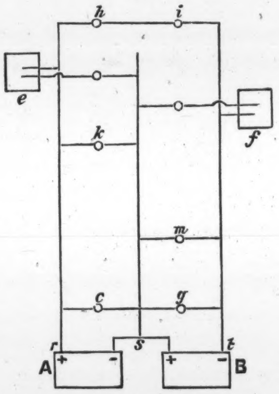

FIG. 2.

"Now transfer dynamo A, fig. 1, to A, fig. 2, and connect in series with another of the same type, B. Belting both to the same engine, and running a third wire from any point on the conductor, *s*, between the two, we have the positive terminal of the combined system at *r*, and the negative at *t*, with the middle wire alike positive to A and negative to B. If the machines be run at their normal speed, the difference of potential between *r* and *t* will thus be 220 volts, and between *r* and *s*, or *s* and *t*, 110 volts, or the proper force for one lamp. If such a lamp, as at *c*, be connected, the A machine will be doing work and the current will return through *s* to its negative terminal. If, instead, *g* be turned on, only B will produce current. In case both *c* and *g* burn at once, the effect will be exactly as if *h* and *j*, or *k* and *m*, were in use, the double E.M.F. working through the double resistance to produce the same number of ampères as before, and the middle, or, as it is technically known, the "neutral" or "compensating" wire, practically cut. If the number of lamps on one side exceed that on the other, a current will flow through the neutral wire to or from the machine carrying the heavier load, and by actuating the needle of an ampère indicator will by its direction show the side most taxed, and by the angle of its deflection serve as a measure of the difference between the two.

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[*] Investigations respecting coreless vortices will be found in a paper by the author, "Vibrations of a Columnar Vortex," *Proc.* R. S. E., March 1, 1880; and a paper by Hicks, recently read before the Royal Society.

[†] See papers by the author "On Vortex Motion" *Trans.* R. S. E., April, 1867, and "Vortex Statics," *Proc.* R. S. E., December, 1875; also a paper by J. J. Thomson, B.A., "On the Vibrations of a Vortex Ring," *Trans.* R. S., December, 1881, and his valuable book on "Vortex Motion."

"Now we are able to illuminate any buildings or spaces, *e* and *f*, by attaching their lamps to the A and B side of the circuit respectively; and supposing the distance of these points from the dynamos to be, for instance, one-half mile we have sent the current over that interval at an E.M.F. double that employed in fig. 1. To secure the same carrying capacity, therefore, we need a wire of but half the cross section used before. But we are actually using but one-half the current previously consumed to do the same work, and hence our two wires need weigh but one-quarter as much as those in the first illustration. The addition of a third wire as an equaliser raises the outlay to three-eights of the original.

"To make this point more clear, notice that the joint resistance of *a* and *b*, fig. 1, is $\frac{150}{2} = 75$ ohms. With 110 volts pressure they absorb $\frac{110}{75} = 1{\cdot}46$ ampères. Place the same lamps at *c* and *g*, fig. 2, and their joint resistance (in series) is 300 ohms. With 220 volts E.M.F. they therefore absorb $\frac{220}{300} = 0{\cdot}73$ ampères. And this one-half the original current, being sent from the dynamos to the lamps at twice the pressure, can be supplied through twice the resistance, or one half the mass of copper. Consequently one-quarter the weight of wires will supply the same amount of light as before.

"That this increased E.M.F. does not alter the energy expended at the dynamo is evident, for whether we consider the first case (110 × 1·46) or the second (220 × ·73) we have the same result, 160·6 volt-ampères or watts, about one-fifth of one electrical horse-power. Thus a vast saving is effected, not only in the weight of the expensive copper conductors, but in the size of the iron tubes, the amount of insulating material needed, the weight of the boxes which join the sections, the expense of laying in the streets, and the cost of any subsequent repairs."

THE ELECTRIC LIGHTING OF THE IRONCLAD "RICHELIEU."

THE electric light is now generally used on war vessels for nocturnal investigations, by means of search lights, but only a few Powers, such as England, France, Italy, and Austria, have adopted electricity for the illumination of the interior of ships.

The advantages of electric lighting were promptly recognised by the principal merchant shipping companies, and the recent installation made by MM. Sautter, Lemonnier & Co., upon the ironclad *Le Richelieu*, has proved that it is the same with vessels of war; but, in this case, the conditions to be fulfilled being more numerous and essentially different, a special arrangement is required.

The Gramme dynamo furnishes a current of 200 to 250 ampères at a normal speed of 580 revolutions; the electromotive force at the terminals is 51 to 52 volts, and the internal resistance does not exceed 0·008 ohm. The electro-magnets are excited in derivation, which absorbs 22 ampères. The machine is used to supply 211 incandescence lamps of 8 candle-power for the interior lighting, and 16 lamps of 30 candle-power for the signals, &c.

The electromotive force of the machine is kept constant whatever may be the number of lamps in circuit.

The low resistance armature is composed internally of 100 bars of copper forming a cylinder 180 millimeters in diameter, and insulated from each other by card-board soaked in a bath of bitumen.

The extremities of this cylinder are turned to form the collectors upon which the brushes of silvered copper wire are supported.

The field-magnets are formed of eight round iron bars of 0·80 millimeters, connecting the base of the machine with the upper plate, and having in the middle the cast iron pole pieces. This machine is extremely strong; at a speed of 580 revolutions it absorbs 25 H.P. to supply 400 lamps of 8 candle-power, or 200 of 16 candle-power. But this speed, although high for a motor driving direct, may be, without injury to the dynamo, raised to 900 revolutions; the electromotive force and the work absorbed are then doubled, and it will supply 800 lamps of 8, or 400 lamps of 16 candle-power. The machine occupies very little space, less than a meter square at the base, and nearly one meter in height. Being used at a low speed it is quite suitable for the lighting war vessels, for as it is worked far below its maximum of production, it will last for a long time.

The Edison lamps installed upon the *Richelieu* are divided into seven circuits, namely:—

1. The day circuit (68 lamps of 8 candle-power). 2. The night circuit (79 lamps of 8 candle-power). 3. The war circuit (16 lamps of 8 candle-power). 4. The machine circuit (26 lamps of 8 candle-power). 5. The sea circuit (22 lamps of 8 candle-power). 6. The navigating light circuit (6 lamps of 30 candle-power). 7. The signal light circuit (10 lamps of 30 candle-power).

All these circuits form branches of the installation, and each serves for a special purpose:—

The day circuit works night and day; it is used for the lower part of the ship, which is dark even during the day; the night circuit illuminates the sleeping berths, cabins, &c.; the war circuit belongs to the ammunition rooms, &c.; the machine circuit serves for examining every part of the machinery, and for making repairs; the sea circuit completes the lighting of the machinery and boilers; the navigating light circuit comprises three stern lights, two side lights, and one lantern; the signal circuit supplies the lights placed in the masts during the night.

All the lamps, except the lanterns of the navigating and signal lights, are Edison B lamps of 8 candle-power, working with 50 volts and 0·75 ampères.

They are variously mounted, according to the places to be lighted, but everywhere special precautions have been taken to neutralise the vibrations produced by the engines and the shocks from the reports of the cannon. For this purpose there is placed between the wall of the vessel and the support a disc of felt 10 or 15 millimeters thick, and each lamp is connected with its support by two small wooden sockets and a spiral spring, which considerably decreases shocks.

In all the sleeping berths and places occupied by the crew, the lamps are enclosed in lanterns which can only be opened by special triangular keys.

Movable apparatus is required in some situations; the lamps are then suspended by three chains.

In the officers' rooms and cabins the supports closely resemble the ordinary form used for candles. They are all nickel and tin plated, and the lamps provided with opal shades.

The masters' cabins are provided with similar apparatus, simply bronzed, and with tin reflectors. The same form is adopted in the machine room. In the passages and store rooms the lamps are simply protected by glass domes. The seven circuits described above are connected with a switch board placed near the machine. Each is manipulated by a commutator which allows of lighting or extinguishing the lamps on any of the circuits at a moment's notice; moreover, in each circuit a certain number of lamps are provided with individual commutators, turned by special keys.

The conducting wires, well insulated, are everywhere placed upon wooden boards fixed to the walls of the ship or enclosed in metal tubes. Their preservation is ensured by covering them with wood.

The sections of the conductors have been carefully calculated and the points of departure of the principal derivations chosen so that in each circuit the difference of potential between the two wires of the last lamp differs not more than a volt from that at the switch board.

As, on the other hand, the difference of potential at the terminals of the machine is practically constant, the total intensity of the current is always proportional to the number of lamps illuminated. No regulation is therefore required on lighting or extinguishing one or several circuits. It is sufficient to turn the corresponding commutators upon the switch board, always letting a short time elapse before turning another commutator, in order to allow the regulator of the steam engine time to act and maintain the speed.

MM. Sautter, Lemonnier and Co. have communicated to the *Revue Industrielle* a very interesting project which might be adopted where a compact electric light installation is required on board a war vessel. Without departing very considerably from the arrangements described above, it would be easy to supply the search lights by a group of machines identical with those which belong to the interior lighting. One of these groups would be sufficient for lighting lamps always in use, and the other would serve alternately for the search lights and the interior lighting. It would even be possible, by means of very simple arrangements, to utilise the disposable currents for the transmission of power to certain portions of the ship, for example, to the repairing room.

In conclusion, this project would consist in establishing in a very small space an apparatus producing electricity, capable of being utilised for interior lighting, for search lights, for arc lights for embarkation and debarkation, and lastly, for the transmission of motive power.

ON ELECTRIC LIGHTHOUSES.

By M. A. DE MERITENS.

THE author, commencing with a short historical sketch of his subject, refers to the discussion raised last year on the spectrum of light according to the source whence it is derived. In the solar spectrum the two central colours, the yellow and the green, represent approximately three-fourths of the entire luminous intensity. The blue, indigo, and violet make up 14 per cent. and the red and orange 11 per cent.

Solar Spectrum.

	Yellow and green	0·75
(*a*)	Blue, indigo, and violet	0·14
(*b*)	Red and orange	0·11
		1·00

The rays from the blue to the violet are the most refrangible, and are almost completely absorbed by fog, whilst the red and orange traverse it easily. A light in the spectrum, of which the blue, indigo, and violet rays (more refrangible) predominate over the red and orange rays (less refrangible), seems as if it ought to carry less far in a fog than one in which the red and orange rays predominate over the blue, indigo, and violet. The electric light is in the former case, and the light of oil and of gas in the latter.

I wish to show that science has penetrated this new fog which has been raised before the voltaic arc.

Above all things it is necessary to call to mind in how small a proportion the range of a lighthouse is increased by a very great augmentation of its source of light. I borrow the following figures and results of calculations from two memoirs by M. Allard—on "The use of the electric light in lighthouses," and on "The intensity and the range of lighthouses." Let us take, as example, a lighthouse of the first rank, using mineral oil, like that of Dunkirk, giving a light of 6,250 carcels. Let us consider at the same time a luminous intensity 20 times stronger, that is, of 125,000 carcels, and seek the difference of the range of these two lights. In the mean state of transparency of the atmosphere for the Channel the ranges corresponding to these two intensities are 53 kilometres and 75·40 kilometres. We have gained 22 kilometres, or 42 per cent. The range has been increased as 1 : 1·42, whilst the intensity has been augmented as 1 : 20.

Let us now consider a less transparent state of the atmosphere, at or below which the air on the Channel remains for about one-twelfth of the year. The ranges are then respectively 24 and 32 kilometres. We have gained only 8 kilometres, or 34 per cent.

Lastly, in foggy weather, such as prevails on an average for 10 nights yearly, the ranges are 3·7 and 4·6 kilometres. We gain less than 1 kilometre, or scarcely 24 per cent., by increasing the light twenty-fold.

These general data being laid down, let us return to the composition of the electric light. It contains less of non-refrangible rays (*b*) than does the light of oil or gas, but in what proportions? In the absence of exact figures, which we do not possess, M. Allard proceeds by hypothesis. He has carried his hypothesis even beyond the limits of possibility by assuming that the electric light is one-half poorer in red and orange rays than the light of oil or gas. He has, moreover, intentionally made the coefficient of penetration of these same red and orange rays unfavourable to the electric light. Under these conditions he has calculated the range in foggy weather on the Channel:—

1. Of the luminous intensity with oil at 6,250 carcels, and finds it 3·805 kilometres. 2. Of a luminous intensity with oil at 125,000 carcels, which he finds 4·740 kilometres; and, 3. Of an electric luminous intensity of 125,000 carcels, which is 4·696 kilometres.

Thus, when the state of the atmosphere is such that an oil-light of 6,250 carcels is only visible at 3,805 kilometres, an oil-light of 125,000 carcels will be seen at 4·740 kilometres, and an electric light of the same intensity will be seen at 4·696 kilometres. The loss of range of the electric light on the hypotheses made is therefore only 41 metres, or less than one per cent. and the real loss is evidently smaller.

It results from these remarkable investigations of M. Allard's that the notions hitherto prevalent on this subject are erroneous. The presence of the refrangible and absorbable rays to which the electric light owes its whiteness and its splendour, is the cause of a corresponding increase in the intensity of the red rays which penetrate farthest in a fog. The lights of oil and gas have only an advantage of one per cent. over the electric light in penetrating power. The experience of sailors had shown this previously, but the learned French engineer has proved it definitely, and his conclusions are everywhere adopted.

The question is thus simplified. As regards spectral composition and penetrative power in fogs all lights are on the some level. It is now needful to examine which light is preferable for the illumination of lighthouses.

The luminous intensity of the 42 electric lighthouses recently established on the coasts of France has been calculated so as to fulfil on the ocean, during 10 months, conditions which oil lighthouses fulfil during six only. The exception (*i.e.*, the time during which a lighthouse is ineffectual) is reduced from one-half to two-twelfths, being thus rendered three times smaller. On the Mediterranean the exception will be reduced to one-fifteenth, that is, seven and a-half times smaller than it has been hitherto. To obtain such a result the lantern of a lighthouse must be able to project to the horizon a light equivalent to 125,000 carcels. Neither oil nor gas, at any cost, are capable of furnishing practically such a luminous intensity. The expenses of maintaining lighthouses with electricity and with oil, as compared by French and English engineers, show that a unit of light obtained by electricity costs from four to six times less than by oil, and from four to five times less than by gas. The more powerful an electric focus the less is its cost per unit of light. Lighthouses of the first rank must therefore be electric.

The author then notices the experiments on electric lighting with reference to lighthouses made at Blackwall, under the direction of Faraday, as far back as 1858. Between 1859 and 1861 numerous attempts at electric lighting were made at the South Foreland with the machines of Holmes, but the result was not satisfactory. In 1862 there was a new trial at Souter Point, still with the machines of Holmes. The intensity obtained was very feeble. Electric lighting soon ceased. In 1863 and 1865 the lighthouses of La Hève received the electric light furnished by the new machines of the Compagnie de l'Alliance. At this juncture our regretted vice-president, Count du Moncel, advised the suppression of the commutator and the use of the alternating currents for the direct production of the light. The result was conclusive, and the electric illumination of lighthouses was rendered practicable. At Odessa in 1866, at Souter Point in 1871, at Gris-Nez and the Lizard in 1878, the lanterns were illuminated with the voltaic arc.

The new dynamo-electric machines of Gramme and Siemens, more powerful than the machines of Holmes and of the Alliance, now made their appearance in lighthouses. The trials commenced at the Lizard, and were pursued at the South Foreland and at the depôt of the lighthouse service in Paris. After experimenting for two years it was found that with the same expenditure of mechanical force the dynamo-electric machines produced double the current of the Holmes and the Alliance machines. The trials were to be continued in the English lighthouses, and to be commenced in those of France, when in 1880 there appeared the magneto-electric machine, which I had just constructed.

It results from the reports of the English engineers, and from the experiments made at the Paris depôt under the direction of M. Allard, that for a given motive force expended, these machines furnish as much, in an alternating current, as do the dynamos in a continuous current. There is no heating either in the bearings or in the movable rings; there is an absolute invariability in the inductors, a steady light in the lamps even with a certain variation in the speed of the motor, such are the advantages which were remarked at the very outset. The inductors of the machine are composed of 40 magnetised bundles for the French pattern, and of 60 for the new English pattern, of which I shall speak below.

The armatures have 80 bobbins for the French pattern and 120 for the new English pattern. These bobbins may be arranged at pleasure, either for quantity or tension, as may be found requisite. M. Lucas, when drawing up the theory of this machine, has supplied us with very elegant formulæ, indicating all the possible groupings. The only fault which can be found with this machine is its first cost, which is higher than that of a dynamo of the same power. But this condition is merely secondary in case of a public service as important as that of lighthouses, in which the certainty of regular work is a main condition. From 1863 to 1884 the lighthouses of La Hève, worked with magneto machines, have given full satisfaction as to regularity. It has not been the same from 1878 to 1880 with the dynamos at the South Foreland and the Lizard. The dynamo machine, notwithstanding its advantages of a reduced bulk and cost, is more delicate, and subject to derangements. The greatest efficacy of its light being at an angle of 45°, a machine must be used of a power at least double to get the same horizontal range as with a magneto. In course of time the collector will be worn out, as everything wears in service. The machine must then be sent back, perhaps by sea, to the workshop where it was constructed. When the rod which serves as a collector in the magneto machine is worn out, the mechanic of the lighthouse can put in a new one in its stead, and the machine will then be in a condition to work for several years.

If an accident happens to the armature of a magneto, the mechanic removes it, or any bobbins which are deranged, and executes the repairs himself.

If an accident happens to the armature of a dynamo it must again be sent back to the works where it was constructed. These considerations have guided the lighthouse boards of France and England in selecting, as they have done, the magneto machine with alternating currents.

Other countries, which are only beginning the installation of their electric lighthouses, have been of the same opinion as the engineers of the two great maritime powers. Russia, Italy, Portugal, and the United States have adopted the magneto machine for their new lighthouses. This question of the machine best suited for lighthouses being thus decided, I must add that where it is required to supply glow lamps, to execute galvano-plastic work, or to drive a motor, I should be the foremost to recommend a dynamo in preference to a magneto.

Since the use of magneto machines has become general in lighthouses the question concerning the power of the permanent magnets which in them serve as inductors has become of greater importance. To the theoretic researches of the savants who have marked out the track to be followed have been added the practical efforts of industrialists. But unfortunately, after the numerous experiments of M. du Moncel, the remarkable investigations of M. Jamin, and the studies—no less ingenious than instructive—of Mr. Hughes, the cause of the phenomena remains unknown. The coercitive force of tempered steel has been determined. We know that it is at its maximum when the tempering has been effected at the greatest heat of the metal in the coldest liquid. But why are certain steels capable of acquiring, under the same conditions of tempering, a magnetic power very superior to certain others? The question remains unanswered. Why does a bar of the purest Sheffield steel make a less powerful magnet than a similar bar of Allevard steel containing a certain proportion of tungsten? Why is a similar bar of steel from the firm of Peugeot, of Valentigney, containing no tungsten, more powerful still? No one can tell. Why does a small telephone magnet, weighing a few hundred grammes, support twenty to thirty times its own weight, whilst one of 25 to 30 kilos, like that of my machines, barely supports three or four times its weight? "Divide the material," I shall be told; "multiply the number of plates as you have done for your induced bobbins—theory indicates it to you." I have made the experiment, and repeated it without obtaining any better result.

There is here an internal work, a molecular arrangement which escapes analysis and which is still a mystery for science. Unprovided with established rules to follow, manufacturers have had to feel their way like the alchemists of old, and they have arrived, without knowing why, at very remarkable results. The firm of Pougeot now manufacture permanent magnets, which have certainly double the power of the old machines of Holmes and of the Alliance. A French engineer, M. Clémandet, has invented, last year, a new system of tempering metals completely different from the old procedures and which, as regards the manufacture of magnets, is full of promise for the future. Instead of plunging the hot metal into water, or any other cold liquid, it is placed under a powerful press which compresses it instantly to the highest degree, and it is then let cool under pressure. The metal may be re-heated, forged, wrought into any desired shape and magnetised. It retains as much magnetism as if it had not been wrought, and as the best magnet-steels.

(*To be continued.*)

THE POST OFFICE AND THE TELEPHONE.

[A COMMUNICATION.]

DURING the past few months the Post Office and telephone controversy has again attracted considerable attention, and much has been said (notably in Glasgow and Plymouth) which, although seeking to condemn the Government, appears to cavil at the Government right to the monopoly, on the ground of its being morally indefensible, rather than dealing with the more debatable question of departmental duty in carrying out the purposes for which it was created. Whether the Government has a right to control the telephone is one of those questions which occupy the very ill-defined ground between legal judgment and technical decision, and as opinion, even that of the highest authorities, is so divided on the subject, it will be better if we recognise an ancient maxim that "possession is nine-tenths of the law," and thus start with the assumption that the Post Office is morally and legally the proper owner of the right to establish telephonic communication.

We propose, then, to inquire what the duties of a telegraph department should be. Whether it should confine its attention to making money for needy administrations, or whether it should endeavour to facilitate communication by every means in its power, compatible with proper regard to the advantages to be gained, whether in the form of revenue or other and equally important advantages to the State, as composed of individuals.

A few considerations of a preliminary nature will now be entered into.

What is the *raison d'etre* of any telegraph company or administration? It exists, primarily, for the purpose of supplying telegraphic communication to the public, and as a natural result of this communication being satisfactory, the secondary purpose is fulfilled, viz., the payment of a good dividend. To err is human, and the error into which telegraph companies may fall, is to render subservient the good communication to the good dividend. Now there are manifestly two ways of overcoming this, by supporting rival and competing companies, or more perfectly by State control. Before having recourse to the latter expedient, we should clearly comprehend the necessity for such a step, especially in liberty-loving England, where State interference is considered characteristic of our "continental neighbours." As companies exist for two main reasons, it is clear that the State must interfere on one or other of those grounds. Either because the communication is not sufficiently perfect or uniform for the public's convenience, or that the dividends form the attractive bait. The latter case may be dismissed as unlikely; in fact, altogether impossible to realise in European countries, at any rate.

It is probable, then, that the telegraph department was formed to take over the existing lines and systems, to blend them into one harmonious whole, to give the public the benefit of a uniform centralised system, to give the benefit of telegraphic communication to those towns and villages which were not sufficiently important to merit the extension of companies' lines, and, above all, to cheapen the rate or tariff chargeable for despatches. Have these obligations been fulfilled? Yes; most emphatically they have. The discordant elements have been reduced to a uniform and smoothly-working system probably not to be excelled. The communication has been extended somewhat erratically, perhaps, to places which it hardly pays to work, and it has cheapened the despatches to a very large degree.

Thus far the telegraph department has done its work in a manner which reflects the greatest credit upon its members. It was created by the nation to serve the nation, and it did so successfully. But with the introduction of the telephone it became evident that other ideas than those befitting a telegraph department were in vogue. Before going farther, let us understand what a telephone is. It is an instrument which came into operation not for the purpose of supplanting the telegraph, but as its auxiliary. It performed services which the telegraphs did not and could not; it was in every way distinct from all pre-conceived notions of a telegraph except in a broad sense; inasmuch, as it was a means of conveying thought from place to place. I do not wish to dispute for one moment that a telephone is not a telegraph in the strict acceptance of the word; but what I do say is that the telephone, as a *local* apparatus, does not and cannot in any way affect the monopoly of telegraphic communication, *as that communication existed before the introduction of the telephone*; for (with, I believe, the solitary exception of the Newcastle A B C exchange) in no instance did the telegraph supply the place of the telephone. Now, how can a traffic which never before existed be *damaged* by the advent of the means for creating that traffic? The question, of course, involves an impossibility; and yet that is very much the statement which the department wished us to believe.

But, even supposing for a moment that the monopoly is good, what should be the action of a department (whose existence is for the purpose of facilitating communication, let it be remembered)? Does it seem consistent with the foregoing consideration that it should impose restrictions on the growth of an auxiliary, that it should oppose it, and limit and vex it at every turn? Should it not have inquired, first, whether it was a desirable innovation; secondly, whether the development could be carried out better by private enterprise than by departmental efforts? The first question is easily answered; the second not so easily. In the case of private management there is a great incentive to inventors to bring forward improvements; in the departmental system it is notoriously the reverse. Hence the chances are that, in the earlier stages at least, the invention would be better developed by remaining in private hands. Perhaps some consideration of this nature actuated the department; at any rate, they took a middle course, one which has proved a continual source of irritation to both the companies and the public, as the citizens of Plymouth and Glasgow will testify.

At this point the position taken up by the telegraph department was anything but a right one. The reason for its existence was forgotten or ignored, and we have forced on us with ceaseless reiteration the cry, "The revenue!" "The revenue!!" as if the one sole object for which so important an individual as the Postmaster-General was invested with office was the coining of a few hundred thousands for the Treasury. No matter whether the public be inconvenienced or no, "The revenue" was far too sacred a matter to be touched. Let us have free trade by all means; let foreign producers enter our markets untaxed, and flood them with their products, their manufactures, their wheat, and beneficial results will follow; but apply the same process to the introduction of a novelty in internal communication and see the change. "The revenue will suffer"; and in that one short sentence is to be found the sum total of all the reasons for denying cheap telephonic communication. Again, it has been stated that the people who would use the telephone are only a fraction of the total population. Granted; but how about their status and position? Do they not represent the capital and life of the country? Is it not by their aid that British manufactures are spread to every quarter of the globe? And yet they were to be denied a means of greatly facilitating their business, because some great financier had got an idea that the "The revenue" was going to "suffer"; an idea which, although previously demonstrated incorrect by results obtained in other countries, appears only now to have been given up in a sudden manner which has shocked some good folks, because, save the mark, it was a *surrender to "noisy clamour."*

At last, presumably owing to a careful though long-protracted consideration of the matter, rather than to any clamourous agitation, the vexatious restrictions have been removed with a generous hand. But even in this carefully-considered and much-waited-for scheme three glaring incongruities remain, which, it is to be hoped, will soon be rectified.

The first is the question of percentage on private line traffic. Whence does the Government obtain its powers to tax private lines? It may be answered that it is merely a question of bargain between the department and the telephone companies, the former conceding part of their rights in exchange for certain cash belonging to the latter. But what a position! A government having recourse to an artifice to obtain control over property which they have no moral nor legal claim on. This, however, is not the worst. Observe the reason given for the absorption of such a large share of the receipts. It is partly on account of the concessions in question, and partly owing "*to the desirability of securing, as far as possible, simplicity of accounts between the Post Office and the companies.*" Was there ever a more shallow excuse for seizing on other people's earnings?

Then, again, as to the question of written messages. It is perfectly easy of comprehension why written messages should be sharply watched; but why, in the name of common sense, one trading body (for the department appears to be little else) should place restrictions in the way of another one doing, or rather helping to do its own (the department's) work appears to be incomprehensible. If A has a certain business which requires the conveyance of articles from a given place, does it seem rational to suppose that he would refuse a responsible person, B, of undoubted respectability and with good securities, the pleasure or honour, or any other advantage of a like nature, of performing his work for him *for nothing*. And when A came to know that his clients much preferred B's way of conveying articles, as being less troublesome to themselves, does it seem probable that he would obstinately refuse to let B do the work. Yes, he would, but only in one case, *e.g.*, if he was a Government department with the power of saying to his clients: "Yes, *you* may prefer B, but I do not choose to employ him, and you know you can't get the work done by anyone but me."

When the question is considered it amounts to this. The Post Office has numerous offices over a city, collecting messages from the business people at fixed centres. The telephone company has, virtually, hundreds of the business people at one centre (the exchange). These business people are desirous of sending a telegram, and instead of being able to send the message *viâ* the exchange without further trouble, they have to write out their message and send it by hand to the nearest telegraph office, manifestly a loss of time, an expense, an inconvenience, and absolutely *no gain* to the department; if anything, an actual loss, for the extensive adoption of the telephone-telegraph system would ultimately lead to the reduction of the staff in local receiving offices, and remove much traffic from the existing wires. It must not be overlooked that this traffic will not be diverted from the department's main lines, for every message would be handed over to the Post Office for transmission after being received from the local subscriber. This, in face of the proposed sixpenny rate, is an advantage not to be overlooked.

The question of wayleaves is one on which Mr. Fawcett would do well to give more explicit information as to his intentions. If he means to give facilities wherever facilities are required, why not say so at once, instead of so very mysteriously hinting at "careful considerations" and judgments on the "merits" of the case.

With the three above-mentioned exceptions the telephone companies have got a fair field enough, and it is possible that Mr. Fawcett will eventually see his way to considerably modify even these conditions. The fact of the monopoly being absent in America is sometimes brought forward as a reason for the rapid growth of the telephone industry in that country. This is improbable. The Americans are a more impressionable race than we are; quicker to see the advantages of any new "notion" than to weigh its æsthetic or decorative qualities against its practical utility.

The field is now open to all, and will soon, let us hope, be even a smoother one than now. The great fault in the calculations of those who are the managers of the State business has been in insisting that "revenue" was to exclude other considerations. They failed to grasp the idea of corresponding advantage to the State in the shape of benefits conferred on the individual.

Be this as it may, the error is being rectified; we can perhaps afford to let bygones be bygones; but let us hope that for the future more liberal views will be taken. The necessities of to-day are not to be judged by the necessities of 50 years ago. Those who think will admit that in these days of applications of science, the dictum applies with peculiar adaptability—*Tempora mutantur, nos et mutamur in illis.*

A. HAMILTON-CHURCH.

Since the receipt of Mr. Church's article we observe that the Postmaster-General has notified to the various telephone companies that he is now prepared to issue licenses in conformity with the concessions announced in the House of Commons on the 7th of last month. In addition to these important concessions he has also conceded to the telephone companies the privilege of connecting the various telephone systems with the postal telegraph offices, thus enabling subscribers to the telephones to transmit telegrams directly from their own offices to any part of the United Kingdom or abroad free of any extra charge. Further, the Postmaster-General has abandoned his claims for a royalty of 10 per cent. to the State on all private wires. We would call the attention of our readers to the articles upon this subject which appeared in our issues of July 5th and August 16th, when they will recognise how completely the progress of events has testified to the correctness of our views then expressed upon the matter.

The *Times*, commenting upon the above announcement in its issue of the 2nd inst., says:—

"We are able to announce this morning that Mr. Fawcett has notified to the various telephone companies that he is prepared to issue licences in conformity with the concessions offered by him in the debate upon the Post Office Telegraphs vote on the 7th of last month. In his private capacity as a thorough-going free-trader he can hardly view with any great favour the monopoly of telephone business secured to the Post Office by an Act drafted long before the telephone had been thought of, and it must be a great satisfaction to him that, notwithstanding the obstacles offered by his official position, he has been able, if not to abandon the invidious privileges of his department, at least to mitigate their operation. He has now gone somewhat beyond the concessions announced in the House of Commons. It was proposed that in return for the advantages offered to the telephone companies they should consent to pay a royalty of £10 per cent. upon private as well as upon trunk wire business. This claim is now abandoned. It was admitted from the first that it would bring in but a trifling sum, and the reason assigned for insisting upon it was that simplicity in the accounts would be promoted by taking the gross returns of the companies. Mr. Fawcett is to be congratulated upon having relinquished a claim which required some stronger justification. Another additional concession, which was strongly urged by Mr. Gray and others in the debate, is permission to the telephone companies to connect their systems with the various post offices, so that subscribers may transmit telegrams direct from their own telephones without extra charge. The changes previously announced in favour of the companies were the abandonment of the claim hitherto made by the Post Office, for an unlimited supply of patented instruments; the removal of all limitations of area, together with the abolition of all regulations depending upon them; and permission to establish call offices for the despatch of oral messages. But while these concessions, taken as a whole, are very agreeable to the companies, as is proved by the considerable rise in the value of their shares, on a rumour of the concessions yesterday, and extremely liberal from the point of view which Mr. Fawcett has adopted, they leave the Post Office in full exercise of very extensive and important rights. It reserves its right to carry on telephonic business on its own account as well as to issue whatever new licences it may think fit. It absolutely forbids any telephone company to receive or deliver a written message, in order that all danger of infringing its telegraphic monopoly may be avoided. It charges £10 per cent. on gross receipts, except, as just mentioned, those of private wires. Finally, while occupying the position of a monopolist of way-leave over the railway lines, and of a competitor for telephonic business, it carefully guards itself against admitting any obligation to lease way-leave or to erect trunk wires for the companies. Mr. Fawcett deserves and will receive the gratitude of the public for having done so much in spite of notorious bureaucratic prejudice. But we can hardly suppose that any one who considers the matter in the light of public convenience will accept these concessions as in any degree final. While they offer substantial relief to the telephone companies, they cannot be said to do much towards popularising the telephone. The claim of the Post Office to a monopoly of telephonic business is maintained as jealously as ever, notwithstanding the relaxation of the conditions on which its rights are delegated. That claim, although no one can question its legal validity, we have always protested against as morally indefensible and practically mischievous. It has stifled telephonic enterprise, and it will continue to do so as long as it exists, no matter what efforts a liberal-minded Postmaster-General may make. The official mind cannot get rid of the haunting fear that the prosperity of the telephone means the depression of the telegraph, and every movement in the direction of liberty is cramped by the official pre-occupation about protecting the revenue. It must be admitted that the telegraph revenue, which is immediately in question, is not in a very flourishing condition, and it seems vain to quote American experience by way of reassuring the department. Indeed, we are not quite sure that it is not in the right when it apprehends a different issue from the competition between telegraph and telephone in this country. The Government telegraph system is burdened with a very heavy capital outlay, and it is managed by a department. These are serious disadvantages in a struggle with unfettered private enterprise, and it is quite possible that if the telephone were as free here as in America, the telegraph would find it very difficult to hold its own. Hence it may be a natural official instinct that prescribes the maintenance of disabling conditions as against the telephone. The public, however, will perceive with growing clearness that this is one of the cases in which official instinct must be set aside by broader views. The Post Office, although intended to be simply a national service, has grown into a revenue collecting agency. We pay through it several millions of indirect taxation every year. There is no particular objection to doing this, so long as the tax does not cripple industry or retard progress, but it will do both if the protection of the revenue is to mean the prevention of the natural developments of business. If the unrestricted use of an important invention for economising time and facilitating business is to be denied to the great body of the people merely in order that they may be compelled to use the telegraph at prices dictated by the terms of a very bad bargain, then every argument against injudicious taxation of commodities comes into play. The telegraph revenue in that case is bought very much too dear, and its protection by artifical restrictions must be condemned on the same grounds as protection of corn or ribands.

"The truth is that the apprehensions of the Post Office constitute the strongest presumption that its policy is mischievous. If the telegraph system cannot stand the competition of the telephone as it does in America, then there is something radically wrong in its constitution. It would be much the best thing for the country, however painful it might be to the official sponsors of the system, that all protective regulations should be swept away and a free field given to the telephone. To whatever extent it may supersede the telegraph, just to that extent, we may rely upon it, will its use be a real economy to the nation. The Chancellor of the Exchequer may get less from the Post Office, but he will have the satisfaction of knowing that the country is all the better able to pay in some other way. As things stand at present, even after Mr. Fawcett's concessions, the telephone must remain the luxury of the few. A private wire and a delicate instrument must always cost something considerable, and the cost will be incurred only by those who are rich enough to pay for a whim or busy enough to save by the outlay. But there is no reason, except the supposed necessity for protecting the telegraphs, why a system should not be organised by which the telephone should be at the disposal of every one who can pay a small fee for his message. We should think it very strange were it proposed to compel every one who desired to use the telegraph to have a private wire to his house or office, but there is really no more reason for such a restriction in one case than in the other. With a public call-office in every important street, and a small staff of active lads, the transmission of a message to any reasonable distance, or even the holding of a conversation with a friend, might be brought within the reach of everybody. At all events, a free-trade Government ought to put no obstacles in the way of this or any other legitimate development of the telephone system. If it cannot see its way to popularising the invention and reaping the profit for itself, it ought not to shut out others from making a commercial experiment, by maintaining restrictions of a purely protective nature based upon powers which it has no moral right to exercise."

REVIEWS.

The Electrician's Pocket-Book. The English Edition of Hospitalier's "*Formulaire Pratique de l'Electricien.*" Translated, with additions, by GORDON WIGAN, M.A. Cassell & Company, Limited, London, Paris, and New York.

We have so recently reviewed the original of this production, that it is unnecessary to again consider it in detail. We do not know of any book of the kind that so thoroughly deserves to be translated into the English language. Mr. Wigan has done his work generally well, and by judicious additions has increased the value of the original volume. There are, however, evidences here and there of want of care in the editing; thus, on page 206, we find a number of resistances which should be given as 1070, 3210, 4280, &c., ohms, stated to be 1·07, 3·21, 4·28, &c., ohms; the general description, also, of the method of battery testing to which these resistances have reference is by no means clear. On page 71 we find the angle of maximum sensibility of the tangent galvanometer stated to be 0°; whilst on page 89 it is stated to be (and correctly so) 45°. Errors are, of course, unavoidable; but a little more care would, we think, have been advisable. A feature in the work is the excellent style in which it is printed, a marked contrast to the original French edition. We unhesitatingly say, in conclusion, the thanks of the electrical world are decidedly due to Mr. Wigan for the really valuable addition which he has made to the English electrician's library.

Electricity: its Theory, Sources, and Applications. By J. D. SPRAGUE. Second Edition. London: E. and F. N. Spon, 16, Charing Cross.

The reputation which Mr. Sprague has earned by the publication of the first edition of his work will by no means be diminished by the issue of the second edition. The latter has been continually enquired for, a fact which is a measure of the appreciation in which the book is held. Much of the success of "Electricity" has been due to the original way in which the subject has been treated, the author not hesitating to attack generally accepted text-book theories in several cases, and we think with good reason. Features in the work are its thoroughly practical nature, and the evident desire to lead the reader to think for himself.

A History of Electric Telegraphy to the Year 1837: *chiefly compiled from original sources and hitherto unpublished documents.* By J. J. FAHIE. London: E. and F. N. Spon, 16, Charing Cross.

This volume is a collection, with a few alterations, of a series of articles which recently appeared in the pages of the *Electrician*. The existence of a historian in the ranks of the electrical army is a welcome fact, and Mr. Fahie has done good service in electing himself to the post, as he has produced a volume of considerable literary merit, and one which will be perused with very great interest. The author has on indisputable authority demolished many of the hitherto recognised beliefs in the claims of certain philosophers to be considered as the discoverers of certain electrical laws, &c. His announcement, however, that Gauss and Weber, and not Thomson, first constructed the mirror-galvanometer, is hardly a correct statement of facts; Thomson's invention was that of employing a ray of light to produce a reflected index-hand which moved over a fixed scale an index-hand which could be observed by any one in the proximity of the scale. In Gauss and Weber's instrument the observations had to be noted through a telescope, and the scale had the appearance of moving in the field of the lens. The general object of Mr. Fahie's work has been to bring forward the hitherto unknown labours of Dr. Davy, whom the author has now clearly proved to have been a chief pioneer in the invention of the electric telegraph. The work of Davy will astonish those who read Mr. Fahie's book; it shows how near a man may be to success without actually attaining it. The book is well worth purchasing.

ELECTRICITY CLASSES.

BELIEVING that it would be interesting and profitable information for our readers generally, we have gathered the following particulars as to the arrangements made at the various institutions in London and the large towns of the kingdom with the view of affording a practical training in the principles and applications of the science of electricity.

On the 25th of June last the Prince of Wales opened the *Central Institution of the City and Guilds of London Institute* at South Kensington which, when fully equipped, will have cost nearly £100,000. The object of this institution is stated to be the raising of the standard of technical education throughout the entire kingdom, by giving "that higher instruction of which the leaders of our industries stand so much in need, and also, and principally, to train teachers for the several technical schools and classes which, owing greatly to the encouragement afforded by this Institute, now constitute an important feature in our educational system." Rooms are to be set apart in this building for experiments in current and statical electricity; for testing the power and efficiency of dynamo machines, of electric lamps and motors; for experiments in telegraphy and in methods of ascertaining the resistance and capacity of specimens of submarine cables and of underground wires. The Central Institution is expected to be open for students in January. The fee for the complete course of instruction for those students wishing to qualify for the diploma will be £30 per annum; but students will be admitted to special courses on payment of lower fees, and arrangements will also be made for gratuitous courses of instruction to be given in the summer months to Technical Teachers. In the meantime, the work of the City and Guilds' Institute is still carried on at the *Finsbury Technical College*, Tabernacle Row, which is intended in future to fulfil the functions (1) of a finishing technical school for those entering industrial life at a comparatively early age; (2) of a supplementary school for those already engaged in the factory or workshop; and (3) of a preparatory school for the Central Institution. Among the industries or trades to which the courses of instruction specially apply is that of electrical engineering. On Friday, Professor Ayrton delivers in the morning an elementary course of lectures on the simpler of the applications of the laws of electricity and magnetism to one or more of the following trades:—Electric lighting, transmission of power and locomotion, telegraphy and telephony, electro-plating and electro-typing, electrical instrument making; and in the afternoon another course on the more advanced applications of the same laws. There is also an evening electrical engineering course, specially suited to the requirements of those who are actually engaged during the day in the various electrical industries. Laboratory classes are held in connection with the lectures, and rooms are set apart in which can be conducted delicate measuring experiments in telegraphy, &c., the testing of electric lamps and motors, and other operations requiring the employment of strong electric currents. The fee for the season for day students is £9, and for the evening classes the fees vary from 6s. to 30s. for the session of eight months.

At *King's College*, London, Professor Grylls Adams, F.R.S., will on the first Monday in October, at 2 p.m., commence a course of lectures on electricity and magnetism, and their applications to electric lighting, transmission of power, &c., in connection with which he will superintend in the Wheatstone laboratory a course of practical work in electrical testing and measurement, with especial reference to electrical engineering. The fee for the lectures is £2 2s. per term, and for the laboratory £4 4s. per term, the terms beginning October 1st, January 15th, and April 16th.

In connection with the *Polytechnic Young Men's Christian Institute*, 309, Regent Street, London, technical classes are conducted by Mr. W. Hibbert, F.C.S., embracing electrical engineering, telegraphy, electric lighting, electrical instrument making and practical electrical work. A special course of instruction in these subjects, arranged to meet the requirements of those engaged in the electrical engineering trades, will be commenced on October 6th, and continued throughout the winter on Monday, Tuesday, Wednesday and Friday evenings. The fees to non-members of the Institute are from 4s. to 10s. per session for each course. Mr. Robert Avey Ward also conducts an electricity and magnetism class on Saturday mornings from 11 to 12, to meet the requirements of pupil teachers and others, fee 4s. per session.

The West London School of Telegraphy is a training school for operators upon the sounder, Morse printer, and single needle instruments. Day pupils pay about 7s. 6d. per week, and evening instruction is given to such as are engaged in business during the day for a fee of £3 3s. for three months.

University College, Bristol.—In the department of experimental physics of this college, lectures and classes, arranged progressively, are given throughout the session, and instruction is given in the physical and electrical laboratory. In the engineering department special courses have been arranged for students studying for the profession of engineering, who wish to include in their professional training some knowledge of electricity and its technical applications, especially with regard to electric lighting and transmission of power, telephones and telephonic systems, telegraphy, electroplating, &c.

University College of South Wales and Monmouthshire, Cardiff.—Though barely 10 months old, and not calculated to become in the highest degree a success till the proposed system of intermediate schools for Wales is in operation, this institution has already upon its books 151 day students, and during the winter terms had nearly 700 night students. The professor of physics is the principal of the college, the Rev. J. Viriamu Jones, M.A., B.Sc., and special provision has been made in the laboratory to enable students to perform the chief electrical measurements requisite in electrical engineering, the workshop being fitted with gas engine and dynamo. The sessional fee for the classes is £3 3s., and for the laboratory £3 3s. In the Lent term a course of 10 experimental lectures on "The Electrical Researches of Faraday" will be given by Prof. Jones on Thursday evenings.

Bradford Technical College.—During the past session a class for the study of electricity and magnetism was conducted by Mr. J. T. Riley, B.Sc., in connection with the Education Department, South Kensington, and at the May examinations the students obtained 39 first class passes and 67 second class. During the ensuing session, which commences on 17th September, in addition to the magnetism and electricity classes, Mr. Riley will also give a course of instruction in telegraphy. The fees are 5s. per class per session.

(*To be continued.*)

SECOND MEMOIR ON THE HYPOTHESIS OF PARTICULAR CURRENTS.

By AUGUSTIN FRESNEL.

I HAVE already remarked that it is not indifferent to suppose that magnetism consists in currents around the axis of magnets, or around each of their particles; that phenomena which are consequences of the former hypothesis, and which are not experimentally realised, ought not to be produced in an observable manner in the second; that this latter supposition is, in fact, the only one whose results agree with the ordinary theory of magnetism which generally represents in a very faithful manner the phenomena of the magnet, so that, to reproduce in all cases these phenomena by means of an electric current, it must be made to pass through the ring-helix, the idea of which I have conceived. I will further add that the particularity that a magnet is not hot, whilst it apparently ought to be on the theory of currents around the axis, is not a difficulty in the hypothesis of currents around the particles. For if an electric current, when traversing a mass of the particles of a conductive body heats it, we do not see any necessity that currents around the particles of a similar mass must heat it also. The circumstances are not identical. The cause of the heat which an electric current develops is not sufficiently known, and our ideas on the constitution of bodies are too incomplete to know if in this case electricity ought to produce heat.

If we demonstrate that a particle surrounded by an electric current represents exactly by its action a particle in which there are, at two opposite points, two principles, two fluids attractive for each other, but each repulsive to itself, with an intensity reciprocal to the square of the distance; considering the line passing through the particle surrounded by a current perpendicularly to the plane of this current as the analogue of that traversing the other particle and passing through its poles, we infer readily from this the mutual action of two magnets on the hypothesis of currents around each particle. It is easy to see that, supposing the currents of equal intensity around all the particles of the length of a magnet bar, the action must emanate only from the surface terminating the bar at each of its extremities, since the actions of the sides, as regards all the particles of the length of the bar, will neutralise each other, and there will remain merely the actions of the exterior sides of the particles at its extremities. The ordinary theory gives the same result, if we suppose the decomposition of the natural magnetic fluid equal in all the particles of the length. Thus, as for the explanation of the purely magnetic phenomena the two theories are in a manner the same; they must have the same properties.

It is not the same with the electro-magnetic phenomena; we must add to the ordinary theory of magnetism the supposition of a certain action between the magnetic fluids of the magnets and the electric current of a connecting wire; whilst, if we admit that the magnetic state consists of electric currents, as experiment shows an action between these currents, we see that there may be one between a connective wire and a magnet.

According to this manner of conceiving the electric constitution of magnets, a connecting wire should not act on all points of their length, as certain experiments might make us believe, but should act only on their poles, and these experiments are explained by the direction of the force acting on these poles, a direction which, for each pole of a magnet, will make an angle with the plane containing the wire and passing through the pole.

We may easily demonstrate that the direction of the resultant of the forces which an indefinite connective rectilinear wire exerts upon each pole of a bar situate in a line perpendicular to the connective wire, is perpendicular to the plane containing the line and the wire, and that the direction of the resultant for a pole is contrary to the direction of the resultant for the other pole. We may examine if, when this bar remaining in the same plane inclines to the connecting wire, and when it inclines to this plane, the resultant is still perpendicular to the plane containing the wire and passing through the pole which we consider, and which, in the latter case, it seems to me should not occur.

The action of magnets emanates only from the surfaces which terminate them at their poles. I have put two similar magnetic bars in contact, end to end, for the entire surfaces, terminating them at their contrary poles, and I have found, on each bar, from each side of the point of contact, up to a certain distance, magnetism of the same nature as that of the end in contact of the bar which I was observing. The intensity of the action of the bars is at its maximum at their extremities, and decreases from the extremities towards the middle.

To conceive this decrease it must be admitted, in the electric theory of magnetism, that the intensity of the currents around the particles increases from the extremities of the bars towards the middle, following a certain law, a law such that the differences between the intensities of the successive currents decrease from the extremities of the bars, following the same law as the intensity of the magnetism, setting out from the extremities, which is, generally, the condition of this law. According to this law the intensity of the currents on a bar, at a finite distance from the extremity ought, mathematically speaking, to be infinitely greater than at the extremity.

If we suppose that the decrease of the intensity of the magnetism from the extremities of bars towards the middle is represented by a logarithmic curve (which may not be strictly true), the intensity of the currents at a given distance from each extremity will be proportional to $\frac{b^d - 1}{b^d}$, an expression in which d is the distance between the extremity and the point for which we are considering the intensity of the currents, the unit being the distance between the extremity and the point at which the intensity of the magnetism is to that at the extremity as $1 : b$.

The intensity of the currents is, therefore, in this case, proportional to $\frac{a^d - c^d}{a^d - 1}$, a being the intensity of the magnetism at the extremity, d the distance, measured from the extremity at which the intensity of the currents is considered, expressed by the distance at which the intensity is c, taken as the unit. We may in the same manner express the intensity of the currents at different points of the length of the bar, by any law of the decrease of the intensity of magnetism.

In order to conceive this decrease of the intensity of magnetism on the ordinary theory, we must admit that the decomposition of the natural magnetic fluid increases in quantity in the particles, from the extremities of the bars towards their middle, following the same law as the intensity of currents in the electric theory. If we suppose that the intensity of the magnetism decreases from the extremities towards the middle, following a logarithmic, the quantity of natural fluid decomposed at any point whatever will be represented by the same expressions as the intensity of the currents, *d* being the distance at which we consider the quantity of decomposition.—*Comptes Rendus.*

NOTES.

Electric Lighting.—In his paper read before the British Association at Montreal, upon the Severn tunnel railway, Mr. J. Clarke Hawkshaw stated that the electric light is largely used both above ground and in those parts of the workings underground where the brickwork is completed. Lights of 2,000 candle-power are suspended at intervals of about 10 chains in the finished parts of the tunnel; much vitiation of the air is prevented by the use of these lights.

The electric light formed a prominent feature in the city illuminations on the occasion of the visit of the Prince and Princess of Wales to Newcastle-on-Tyne on August 20th and 21st. Three powerful arc lights, each of 8,000 candle-power, were shown in different parts of the city; one of these was placed in the beautiful lantern tower of St. Nicholas Cathedral, and was visible for many miles around, the effect produced being very fine, and much admired by the large crowds which gathered to see it. The other two lights were placed in the principal streets, one of them being just opposite to the gas office, where an extensive gas illumination was exhibited; the contrast was very striking, the superior brilliancy and purity of the electric light giving rise to much comment. These installations were carried out for the different parties by Messrs. J. H. Holmes & Co., Electric Light Engineers, Newcastle-on-Tyne. The same firm has also lighted a Polytechnic Exhibition at Hetton, Co. Durham, for four weeks by means of 45 Swan lamps and one arc lamp, worked in parallel circuit from the same dynamo, with perfect success, attracting large numbers of people, to whom the electric light was a novelty.

The electric light installation at the Mechernich Mines in its once volcanic Eifel district in Rhenish Prussia, has now had a fair trial for more than three years and has proved a complete success, states *Engineering.* The expectation that it would both facilitate the operations and increase their security, has fully been realised, and an extension of the plant is now being carried out. Messrs. Siemens and Halske, of Berlin, undertook the work, which was superintended on their behalf by Mr. Boeddinghaus. An open working 2,000 feet long, 1,000 feet wide, and over 300 feet deep, in which 300 men and 20 horses are continually occupied, was first to be supplied with the electric light. This part of the mine is excavated in steps, the horizontal terraces being provided with rails. Ordinary lamps in globes on poles were out of the question, as blasting operations continue throughout the day and the shots would soon have made havoc of the lamps. After several trials two powerful lamps, of 3,000 candles each, were erected at the upper margin of the pit where they were fairly out of the reach of the projected stones; and reflectors were fixed to throw the light down upon the steps. To find the proper positions for these powerful lamps and to avoid too dark shadows caused some difficulty. But the illumination was finally rendered most efficient, and the open pit with the light playing on the whitish grey rock affords a fine spectacle. As any interruptions, even for short periods, such as those occupied in renewing the lamp carbons, would be dangerous, the whole plant is double; each lamp receiving its current from a D_2 dynamo. No hitch of any kind has occurred, and the safety of the miners has decidedly been augmented. It was formerly not always possible for the superintendents to see whether the loose mass resulting from the blasting operations had been properly removed, and frequent minor accidents arose from the débris falling down upon the miners engaged on the step next below. The work can now be controlled much better than before when petroleum lamps and hand lamps were in use. The cost shows a saving of about 4d. per hour in favour of the electric illumination. The satisfactory results obtained in the open working induced the company to introduce the electric light down in the subterranean galleries. The ore forms little concretions of sand and galena scattered all through the rock; the whole mass has therefore to be brought to day to be disintegrated and sifted, and the mining proceeds in parallel and cross galleries, which are constantly being widened until they become 90 feet in width, and 70 feet in height, by sometimes 300 feet in length. The operations in themselves would not require much light if there was not always danger threatening from loosened pieces of rock. Pitch torches were formerly employed to examine the bore holes and fissures round them after each explosion. It was a question whether the arc lamp would answer for this purpose in the smoky atmosphere. For the first experiments, arc lamps of 3,000 and 1,000 candles were used, with the positive carbon in the lower holder. The effect was brilliant, yet the light did not penetrate the white smoke cloud which collects at the upper wall immediately after the shot. But as the smoke settles within ten minutes, it was thought advisable to acquiesce in this interruption of a few minutes, and to use smaller lamps of 350 candles, which proved quite efficient. Of these, there are ten in use with about 10,000 feet of lead cable, the cable being partially elastic, as the lamps with their wires have to be removed when the blasting is to take place. The lamps were originally supplied with hexagonal lanterns with obscured glass to protect the eyes of the miners. The glasses were of course soon broken, but no complaints are said to have been made about the naked electric lights. The proprietors of the mine have decided upon an extension of the installation.

An electric light of 24,000 candle-power, announces the New York *Electrical Review*, is to illuminate all the dangerous portion of the Hell-Gate approach to New York City. The light is stated to be in some measure an experiment, and if it proves a success, as the Lighthouse Board have every reason to expect, a move to place a similar one on Governor's Island will be made.

The Thomson-Houston Electric Light Company has nearly completed their new model station at Lynn, Mass. The plant at the start, we learn from an American contemporary, will consist of four dynamos, driven on the independent system by four Westinghouse automatic engines of 50-horse power each.

An account is to hand of a fire which occurred in a theatre in New York a fortnight ago, which is alleged to have been attributable to the use of the electric light. The supposed origin of the conflagration is thus described :—"The piece of scenery that had taken fire was a set tree used in the first act of the new play. Just as the curtain falls on that act Sieba is seen sitting in a bower in the set tree. The bower is illuminated by two Edison incandescent electric light bulbs. In the last act or transformation scene the stage is brilliantly lighted by electricity. It is supposed that after the first act the circuit connecting the two lights in the cellar with the generator was not shut off, and during the last act the bulbs were broken and the scenery thus ignited."

The following information will probably be of interest to the shareholders in the South African Brush Electric Light Company. The Diamond Fields *Advertiser*, in noticing a meeting to be held at Kimberley, for the purpose of deciding as to whether the electric light shall continue in public use or not, says :—"As applied to Kimberley the light has been an unqualified success, and has been a great boon to the inhabitants as regards both the convenience and security of night travelling in and around the town. To how great an extent the safety of our streets has been enhanced it would be difficult to estimate. But some idea may be formed from the fact that outrages are seldom reported, and that the thoroughfares are more free from danger. This has been so marked that it has been well said that each lamp is equal to ten policemen. When fires occur at night, as is most frequently the case, very little looting takes place, because any irregularities of this kind are now so easily detected that gentlemen whose activity would otherwise lead them to secure the goods for their own benefit instead of trusting to the salvage, do not care to run the risk when the silver rays of an electric lamp are radiating around them. The company has never gone thoroughly into the matter of lighting the mines, theatres, clubs, churches, and private houses, but this could easily be done by the adoption of incandescent lamps, and there can be no doubt but that the results would prove to be of a highly satisfactory nature."

Telephony in Eastern Europe.—Servia possesses one telephone line, one kilometre long, connecting the Ministry of the Interior and the Prefecture at Belgrade. Bulgaria and Luxembourg have not a yard of line at work at present. Turkey has three lines, one used by the Administration of Telegraphs, the second used at a life-saving station on the Black Sea, and the third belonging to the Eastern Telegraph Company and the Ottoman Bank. The above lines represent a total length of wire of 41 kilometres.

Telephones.—A correspondent writes as follows :—Could any of your correspondents say if the public is at liberty to use the receiver known, I think, as the "Mechanic" receiver, with parchment diaphragm, and lately made and used by the London and Globe Telephone Company? I was led to believe it was public property, and could be made and used by any one without interference. Further, can telephone wires be carried over any of our large cities, such as London, Glasgow, or Edinburgh, without permission from the authorities, for private communication? Has there been any decision giving the free use of carbon as a transmitter without a diaphragm in conjunction?

The Chinese Telegraphs.—The Great Northern Telegraph Company informs us that the Chinese Telegraph Administration notifies that from 1st September until further notice private telegrams to stations on the Chinese land-lines (Pekin, Tientsin, Hankow, Foochow, &c.) must be written in plain English; commercial telegrams in code or cypher will not be accepted. These restrictions do not refer to neutral Governments' telegrams, nor to telegrams to the cable stations, Shanghai, Amoy and Hongkong.

The Eastern and Indo-European Telegraph Companies have since notified the interruption of the Chinese landlines beyond Chining, thus cutting off telegraphic communication with Tientsin and Pekin.

Egyptian Telegraphs.—In the *Times* of Saturday last appeared a number of telegrams from its correspondent at Wady Halfa, apparently dispatched at different dates from the 26th ult. Alluding to these, the correspondent of the *Times* at Cairo said : "The above accumulation of telegrams exemplifies the want of management of one of the dual administrations. Mr. Floyer, the Inspector-General of Egyptian Telegraphs, being absent at Dongola (where I regret to hear he is reported to be ill with small-pox), the telegraph service, forming part of the railways mixed administration, becomes immediately disorganised. Finding that telegrams were taking three days in transmission here from Wady Halfa, I ventured to ask General Wood to remonstrate with the clerks. The immediate effect was the arrival of four days' telegrams. The service generally is fairly conducted; but like all Egyptian departments, it collapses the moment that the European hand is withdrawn, and so continues until that hand is reimposed."

Telegraphing from Alexandria on Sunday, the *Times* correspondent further said : "There is again delay in the receipt of messages from Upper Egypt. Unless this matter be immediately attended to, the telegraphic service will certainly break down under the extra pressure during the expedition. It seems, however, useless to give such a warning." A still later telegram said : "The condition of the railway and telegraph lines in Upper Egypt demands the earnest attention of the authorities."

Reuter's Company complained of similar irregularities, stating that a message occupied 61 hours in transmission from Wady Halfa to Cairo, and further remarking that the Egyptian telegraph department, with a staff of native clerks, is utterly incompetent to cope with the existing pressure of work.

American Telegraphs.—The United States census returns for the decade to the end of 1882 gives exhaustive statistics respecting the various methods of inter-communication, and these are very interesting. The report upon telegraphs opens with a brief discussion of the statistics. The tables contain a general financial exhibit, a statement of quantity of business, number of employés, and description of lines. The report on telephones is of a very similar character. In regard to this it should be borne in mind, remarks the *Times*, that the telephone was in its infancy during the year to which the statistics refer, and that its use has increased enormously during the three years and a half which have elapsed since. Following this report is an important paper on the postal telegraph service in foreign countries. It gives the history of the postal service in each country where it exists, sketches the methods of business management, and compares the administration by the Government with that by private companies, both as to cost and efficiency. In nearly every civilised country, except the States, it is found that the telegraphs are in the hands of the Government. Except in the case of Great Britain, there is no country for which statistics are given where the revenue of the telegraphs has covered expenditure."

The Projected Telegraph Line to Bokhara.—The correspondent of the *Times* at St. Petersburg writes :—"If the news of the Bokharan Ameer having consented to the extension of the Russian telegraph lines through his territory be true, the first special embassy of General Rosenbach, with Colonel Matveieff at its head, has at last won a success denied to several of its predecessors. Until now the Russian wires from Tashkend have gone only as far as Katta Kurgan, on the frontier. The Russian Government has more than once raised the question of carrying them on to Bokhara, but has never yet been able to obtain the willing assent of its Asiatic vassal. The last attempt was made through Prince Wittgenstein, at the head of an extraordinary embassy to the Ameer, in December, 1882. The Ameer then told the Prince that the Mollahs and Ulema, who already twitted him with listening too much to Russian advice, were strongly opposed to the introduction of the telegraph and to European innovations generally, and that their influence among his subjects was too strong to be disregarded. 'It is not the fear of opposition which makes me give a negative reply to your request,' said the Ameer to Prince Wittgenstein, as reported by one of the members of the embassy; 'how can I help it? Take Bokhara, if you will. I will not resist; I am too old. But if you find it necessary to protect and support me on my throne, then you must take into account my views in this matter, as they cannot be neglected if I am to retain my dignity in the eyes of the people. It would give me much pleasure to fulfil the wish of the Governor-General, and all the more so since it would also please my august protector the White Czar; but, unfortunately, I cannot consent without exciting my people to rebel against me.' In the period of a year and a half that has elapsed since the Ameer gave this answer circumstances must have changed very much, or the Russian authorities have possibly this time placed their wishes and plans before Muzafar Eddin in a more decided and, it may be, in an altogether irresistible manner. In any case, the union of Tashkend and Bokhara by telegraph is regarded by the Russians as a very important matter for Russian commerce as well as Russian policy. Competition on the Bokharan markets with English goods brought by way of India will be immensely promoted and facilitated, think the Muscovite merchants, by this telegraphic advance, and the Russian Government will possess a telegraph outpost in Bokhara of great importance."

A Telegraph Wanted. — A deputation from the inhabitants of the Upper Hastings and Manning district, New South Wales, we learn from *The Colonies and India*, recently waited upon the Hon. J. Norton, Postmaster-General to urge the establishment of some system of communication, telegraphic or telephonic, between that district and Sydney, by way of Port Macquarie. Messrs. J. H. Young and C. J. Roberts, the members for the district, introduced the deputation. Mr. J. H. Young said that the inhabitants of the Upper Hastings and Manning district suffered great inconveniences for want of some system of communication for connecting the various towns and villages on the Hastings River with one another and Port Macquarie. The farmers and those engaged in carrying on the river traffic annually suffered heavy pecuniary losses, owing to the absence of telegraphic communication with Port Macquarie. Many of the farmers lost £50 and £100 per year for want of proper means of obtaining prompt and reliable information concerning the markets. The Postmaster-General thought the deputation had made out a good case, and he would give the matter his careful consideration, and, after consultation with the Superintendent of Telegraphs, would see what could be done to meet what seemed to be a deeply-felt want.

A Submarine Telephone Cable.—The Sunset Telephone and Telegraph Company, of California, the New York *Electrical World* states, has laid across the bay at San Francisco to Oakland, about 4½ miles of a seven-conductor gutta-percha insulated submarine telephone cable. This cable was furnished in October, 1883, by the Bishop Gutta-Percha Works, of New York. The cable is now in excellent working order, and the telephone service through it to Sacramento is stated to be excellent.

The Mackay-Bennett Cable.—The *New York Herald*, of August 23rd, contained a cable news despatch from Paris, which was received "by the Mackay-Bennett Commercial Cable."

The Nile Expedition.—For the purposes of the expedition about to be sent to Khartoum to relieve General Gordon, the Royal Engineer Telegraph and Railway Corps, with over 100 miles of land wires and 50 miles of cable for laying in the bed of the Nile, left Gravesend in the hired transport *Rewa* on Wednesday. They were thoroughly equipped with stores of every description for telegraph, mining explosives, and surveying. The detachments consist of men of every trade, to the number of nearly 400. This is an unusually large number for a departmental corps like the Royal Engineers, and fully indicates that the expedition is expected to be by no means an easy matter.

Telegraph Revenue.—The receipts from April 1st to August 30th of the present year were £755,000 against £750,000 from April 1st to September 1st, 1883.

Barracks Struck by Lightning. — A Calcutta telegram says:—The artillery barracks at Nassirabad were struck by lightning on Saturday evening. The flash struck the upper storey first, passed through the wall, and injured two women. It then crossed to the other side of the building, leaving no trace of its path, but killing six men in its course out through the open door.

The New Regulations for the Prevention of Collisions at Sea.—By a recent Order in Council the following is the rule for telegraph ships:—The ship, whether a steamship or a sailing ship, employed in laying or in picking up a telegraph cable, shall at night carry in the same position as the white light which steam ships are required to carry, and if a steamship in place of that light, three lights in globular lanterns, each not less than ten inches in diameter, in a vertical line over one another, not less than six feet apart; the highest and lowest of these lights shall be red and the middle light shall be white, and they shall be visible at the same distance as the white light.

Ships' Lights.—An "Officer of the Watch" writes as follows to the *Times*: "In the June number of the *Nautical Magazine*, a letter appeared pointing out the necessity of screening all lights about the decks of ships at sea, except those which are required by the Board of Trade for the prevention of collision, and stating that the Board of Trade Surveyors would do well to see that proper means were at hand for so doing, as the chances of collision would be thereby diminished. On my last homeward passage, in the Bay of Biscay, a large outward-bound steamer was passed between 8 and 10 o'clock one night on our starboard side, and so great was the glare from the lights in her deck saloon (which I took to be lighted by electricity) that her green light was completely outshone and could not be seen though well within the range of visibility. I should venture to say that from the size and speed of the ship she belonged to one of the finest lines of steamers running, and it seems to me rather strange that those in authority in the managing departments of large steamship companies are not alive to what might be a very fruitful source of collision. Had dense smoke obscured the masthead light of this steamer, the direction in which she was travelling would have been left to conjecture."

Patents in 1883.—The report of the Commissioners of Patents for the year 1883 was issued on Wednesday, and states that the number of applications for letters patent during the year was 5,993, being 248 less than the preceding year. The results of the proceedings relating to patents are as follows:—Applications for letters patent, 5,993; letters patent sealed thereon, 3,958; letters patent void, the patentees having neglected to file final specifications in pursuance thereof, 63; letters patent consequently remaining in force, 3,895. Of these, final specifications were filed in respect of 3,602; complete specifications in respect of 293. From these must be deducted lapsed applications, which are due to applicants having failed to seal their patents, 2,034; or to patentees having neglected to file final specifications, 63; and one application under opposition to grant or sealing of letters patent, making a total of 2,098, and leaving the number of patents remaining in force, 3895.

English Scientists in America.—The John Hopkins University announces a special course of lectures on molecular dynamics, to be delivered at Baltimore by Sir William Thomson, F.R.S., Professor of Physics in the University of Glasgow, Scotland. Professors and students of physics from other institutions are invited by the University to attend. The introductory lecture will be given on Wednesday, October 1st, and the other lectures will follow on consecutive days; there will be 18 in all.

The Compania Telefonica.—"La Uruguaya," in Monte Video, affords a striking instance of the rapid development of telephone exchanges. Commencing business only on the 1st February last, it had 632 subscribers on the 1st July. At the former date, the River Plate Telephone and Electric Light Company was the only company at work in that city, and had about 450 subscribers, so that the new company appears to have exceeded its rival by nearly 50 per cent. in the short period of five months. The rapid progress of the new company is attributed to the superiority of the instruments it uses (the Bell and Blake) over the Gower-Bell in use by the older Company.

A Morse Relic.—The editor of the *Canadian Electrical News* has in his possession a piece of the original old style white paper which ran through the first Morse instrument at Baltimore, on the first public line built, running from Washington. It is two feet six and half inches long, torn nearly straight off at each end, and is one and a half inches wide. The raised Morse characters run directly along the centre, from one end to the other, and were transmitted by the hand of Professor S. F. B. Morse, the father of the telegraph, on April 28th, 1846, from Washington to Henry J. Rogers, who was receiving operator at Philadelphia, Pa. The telegraphic characters are well embossed, clear, and easily read, and would indicate that the Professor was a good operator. The translation is part of a telegram from the Secretary of the Treasury, Bibb to Mr. H. J. Rogers, and reads as follows:—"P. M., yours received. I never doubted friend Rogers's politeness or his disposition. All is O.K."

The Philadelphia Electrical Exhibition.—A *Times* telegram from Philadelphia states that the International Electric Exhibition was opened in that city on Tuesday. Mayor Smith spoke a few words of welcome, and the Rev. Dr. M'Intosh offered prayer. Mr. William P. Tatham, president of the Franklin Institute, having delivered an address, Governor Patteson formally opened the exhibition. The British Government was represented at the opening ceremony by Captain H. R. De Wolski, of the Royal Engineers. The exhibits, it is stated, are not yet properly arranged, but it was expected that they would be in order by the end of the week. The secretary of the Exhibition has received a communication from the officers of the Royal Society of London to the effect that that body has appointed the following eminent scientists to represent it at the Exhibition:—Dr. John Hopkinson, F.R.S.; Mr. W. H. Preece, F.R.S.; Lord Rayleigh, D.C.L., F.R.S., and Sir William Thomson, LL.D., F.R.S.

City and Guilds of London Institute.—The programme of technological examinations for the year 1884–85 indicates the continuous growth of this part of the institute's operations. As each new subject is added to the programme, classes are formed in which the operatives engaged in the trades to which the syllabus refers receive a course of scientific and technical instruction. To the work done in these classes under the joint direction of the Science and Art Department and of the City and Guilds of London Institute, the Royal Commissioners on Technical Instruction referred with considerable satisfaction in their recently-issued report.

Bellhanging.—The Commissioners of Her Majesty's Works and Public Buildings are prepared to receive tenders for the execution of pneumatic and electric bellhangers' work for public buildings, &c., in the London district. The contract will be for three and a half years from the 1st of October, 1884. A printed schedule, with conditions and a form of tender, may be obtained at Her Majesty's Office of Works, 12, Whitehall Place. The tenders are to be delivered at Her Majesty's Office of Works, on Wednesday, the 17th inst.

Saunders and Son v. The United Telephone Company.—In this case the defendant company submitted to a perpetual injunction restraining it from stretching, placing, or affixing over or upon, or to the roof or other part of the warehouses of the plaintiffs, situate in Cannon Street or Budge Row, any overhead wires.

Incandescent Lamp Bulbs.—We understand that Messrs. Woodhouse and Rawson have now acquired the amalgamated patents covering the process for silvering bulbs of incandescent lamps, and that they are now quite prepared to undertake orders for silvering lamps of any make, having laid down the necessary plant for carrying out the process.

Enterprise in Electrical Journalism.—Our Parisian contemporary, *La Lumière Electrique*, has, we learn, sent a scientific mission of six of its staff to report on the Exhibition at Philadelphia, and the state of electrical industries in America.

Dissolution of Partnership.—The partnership heretofore subsisting between Charles Ernest Spagnoletti, Samuel Griffith, and Reginald Peter Northall Lawrie, manufacturers of electrical railway signalling and general telegraph and electric apparatus, at Reading, has been dissolved.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Great Western Electric Light and Power Company, Limited and Reduced.—An order of the Chancery Division of the High Court of Justice, dated 6th ult., and filed on the 26th ult., confirms the resolutions for the reduction of the capital passed at the extraordinary meetings held on the 6th and 29th of March. The order also directs that the words "and reduced" form part of the title of the company for one month from the date of the order.

Brixton District Electric Light Supply Company, Limited.—An agreement, dated 28th ult., between Mr. Alexander Leslie Fyfe and the company was filed with the documents of the company on the 28th ult. The agreement is supplemental to an agreement dated 23rd May, five days before the registration of the company, and relating to the purchase of certain property from Mr. Fyfe Main, and to his appointment as general manager. The former agreement is now declared to be adopted by the company.

British Indian Electric Light and Power Company, Limited.—The annual return of this company, made up to the 21st ult., was filed on the 1st inst. The nominal capital is £250,000 in £5 shares. 301 shares have been allotted, but no call has been made or paid thereon.

At an extraordinary general meeting of the company, held at 5, Austin Friars, on the 21st ult., by adjournment from an extraordinary general meeting at the same place on the 14th ult., the following resolutions, passed on the 23rd July, were confirmed, viz.:—(1). "That this company be wound up voluntarily." (2). "That Mr. Henry Thomas M'Neale, of 5, Austin Friars, in the City of London, contractor, be appointed liquidator of the company, for the purpose of such winding up."

British Insulite Company, Limited.—The registered office of this company is removed from 20, Coleman Street, to Charlton, Kent.

Simplex Electric Light and Plant Company, Limited.—The registered office of this company is now situate at the Valley Mill, Eccles, near Manchester.

Great Northern Telegraph Company, Limited.—Series B Debentures.—The interest due 1st September will be paid by Messrs. C. I. Hambro & Son at their offices, 70, Old Broad Street, E.C.

London Platino - Brazilian Telegraph Company, Limited.—Six per cent. Debentures.—The coupons due on the 1st September will be paid by Messrs. Glyn, Mills, Currie & Co., 67, Lombard Street, E.C.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotatns, Sept. 4.	Business Done.
		ELECTRIC LIGHT.			
40,000	5	Anglo-American Brush Co.	3	1½ - 1¾	1⅝
		Do. Do.	5	3 - 3½	
30,000	5	Australasian E. L., Power & Storage Co.	4	..	
24,900	10	British Insulite Co., Ld., "A" Shares..	6	..	
25,000	5	Gt. Western Electric Light & Power Co.	2½	¼ - ½	
47,233	5	Hammond Elec. Lt. & Power Sply. Co.	5	¼ - ½	
40,000	5	Indian & Ori. Electl. Storage Wks. Co.	2¼	..	
250,000	½	Maxim-Weston Elec. Lt. & Power Co. ..	½	1/16 - 3/16	
40,000	5	Pilsen-Joel & Gen. Elec. Lt. Co.	3¼	..	
20,000	5	S. African Brush Elec. Lt. & Power Co.	2½	..	
100,000	5	Swan United Electric Light Co., Ld.	3	..	1/16
		TELEGRAPHS.			
1,892,480*l*.	Stk.	Anglo-American, Limited	100	30½ - 31½	30¾
2,553,760*l*.	Stk.	Do. Pref. } Def. receiving no div. until	100	54½ - 55½	55. ⅛
2,553,760*l*.	Stk.	Do. Def. { 6 p. c. paid to Pref....... .	100	6¾ - 7¼	7
130,000	10	Brazilian Submarine, Limited	10	10¾ - 11	10¾
16,000	10	Cuba, Limited	10	10¾ - 11¼	11⅛
6,000	10	Do. 10 per cent. Preference ..	10	16½ - 17½	
13,000	10	Direct Spanish, Limited	9	4½ - 5	
6,000	10	Do. 10 per cent. Preference ..	10	14¾ - 15¼	
65,000	20	Direct United States Cable, Ld., 1877 ..	20	9⅞ - 10⅛	9 15/16. 10
100,000*l*.	100	Do. 6 per cent. Deb., repayable 1884	100	98 - 102	
380,000	10	Eastern, Limited	10	11⅜ - 11⅝	11⅜. 7/16
70,000	10	Do. 6 per cent. Preference......	10	13¼ - 13¾	13½
200,000*l*.	100	Do. 5 do. Debs., repayable Aug. 1887	100	100 - 103	
200,000*l*.	100	Do. 5 do. do. Aug. 1899	100	103 - 106	104
500,000	Stk.	Do. 4 do. Debenture Stock	100	97 - 99	
250,000	10	Eastern Exten., Australasia & China, L.	10	11½ - 11¾	11⅝
320,000*l*.	100	Do. 6 p. c. Debs., repayable Feb. 1891	100	109 - 112	
640,000*l*.	100	Do. 5 p. c. (Aus. Gov. Sub.) Deb. 1900	100	103 - 106	
100,000*l*.	100	Do. 5 per cent. Debenture, 1890	100	102 - 105	
550,000*l*.	100	Eastern & South African, Ld., 5 p. c. Mort. Deb. Rg. redeemable 1 Jan. 1900	100	103 - 105	
22,050	10	German Union Telegraph & Trust, Ld.	10	9¼ - 9¾	
250,000	10	Globe Telegraph & Trust, Ld.	10	6⅝ - 6⅞	6¾
250,000	10	Do. 6 per cent. Preference	10	12½ - 12¾	12 11/16. ¾
150,000	10	Great Northern	10	13¼ - 13½	13½
100,000*l*.	100	Do. 5 per cent. Debentures ..	100	100 - 103	
300,000*l*.	100	Do. 5 per cent. Debentures ..	100	103 - 106	
81,200	10	India-Rubber, Gutta-Percha, & Tel. Wks.	10	23 - 24	23
100,000	100	Do. 6 per cent. Debs., 1886	100	102 - 105	
18,000	25	Indo-European, Limited	25	31 - 32	
40,000	10	London Platino-Brazilian, Limited	10	3¾ - 4¼	
100,000	100	Do. 6 per cent. Debentures ..	100	100 - 102	
10,000	8	Reuter's, Limited	8	8 - 8½	
338,225*l*.	Stk.	Submarine	100	165 - 175	
75,000	1	Do. Scrip	1	1½ - 1¾	
4,200	Cert.	Submarine Cables Trust	100	100 - 103	
37,350	12	Telegraph Construction and Mainten.	12	32½ - 33½	
150,000	100	Do. 6 per cent. Bonds, 1889 ..	100	105 - 108	
186,750	5	Do. 2nd Bonus Trust Cert. ..	2½	1½ - 1¾	
30,000	10	West Coast of America, Limited	10	5¾ - 6¼	
150,000*l*.	100	Do. 8 per cent. Debs.	100	110 - 113	
45,181	15	Western and Brazilian, Limited	15	6⅝ - 6⅞	6 15/16. ⅝. ¾
24,729	7½	Do. Preferred	7½	4¾ - 5	
24,729	7½	Do. Deferred	7½	1¾ - 2	1 15/16
200,000*l*.	100	Do. 6 p. c.. Debs. "A" 1910 ..	100	101 - 104	
250,000*l*.	100	Do. 6 p. c. Mort. Deb. B. '80, red. Feb. 1910	100	95 - 97	
1,500	$1,000	Western Union 7 p. c. 1 Mort. (Bg.) Bds.	$1,000	123 - 125	
1,030,000*l*.	100	Do. 6 per cent. Sterling Bonds	100	100 - 103	
88,321	10	West India and Panama, Limited	10	⅞ - 1⅛	
34,563	10	Do. 6 per cent. 1st Preference	10	7¼ - 7¾	
4,669	10	Do. 6 do. 2nd do. ..	10	4¾ - 5¼	
		TELEPHONES.			
224,850	1	Con. Tele. & Mainten., L., Nos. to 154,165	1	¼ - ⅜	
225,000	1	Oriental Tele. Co., Nos. 80,001 to 300,000	½	⅛ - ⅜	
100,000	5	United Telephone Co.	5	12 - 12½	12½. 7/16. ½. 7/16. ¼. ⅜
20,000	5	Do. New, issued at £2 pm.	2	6 - 6½	6⅜. 9/16

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of August was 2,916, estimated to produce £2,375, against 2,470 messages, producing £2,815 in the corresponding month of last year. The receipts for the month of May, estimated at £2,950, realised £2,973.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 29th, 1884, were £2,620, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st August, are £2,490 as compared with £2,074 in the corresponding period of 1883.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of August were £1,173, against £1,547 in the corresponding period of last year.

THE ORGANISATION OF THE POST AND TELEGRAPH SERVICE IN FRANCE.

(*Continued from page* 171.)

THE pneumatic system, which dates from the year 1867, had on the 1st January, 1878, a total length only of 33 kilometres, which represented an average of 2·692 metres of tubes laid per annum from the time of its being introduced.

At present, the system has a total length of 140 kilometres, but to this should be added 20 kilometres of piping, which assure the communication with the air-pumping centres.

It consists of a principal system with duplicate lines, into which end 12 auxiliary systems, with different branches, besides a direct duplicate line between the central telegraph station and the stock exchange.

The number of offices opened to the service of the pneumatic tubes amounts to 75, including those at the Chamber of Deputies and the Senate.

The 140 kilometres of tubes are worked from eight stations where steam engines are placed, with a total power of 315 horsepower. Besides, four auxiliary hydraulic motors can eventually be made use of for that purpose.

The carriers start every three minutes on the direct line between the central telegraph station and the stock exchange; every five minutes on the principal system and the auxiliary lines, and every quarter of an hour only on some of the branch lines.

Independent from the work of extending the pneumatic system, the forwarding and receiving apparatus of this service have been modified so as to bring them to a single type, and thus to facilitate the work. At several stations air pumps of an improved type have been placed.

213 tube assistants look after the working of the pneumatic tubes.

A dispute with the City of Paris, which in 1882 claimed import dues on materials required for the establishment of pneumatic lines, delayed for some time the work of extending this system. The Council of State has inserted in the decree of the 12th July, 1882, which fixes the dues on metals payable to the City of Paris, a clause stipulating that those dues are not to be applied to telegraph material. A bye-law of Public Administration, dated the 8th December, 1882, further has specified, that the exemption from any town dues, as fixed by the decree of 1870 for materials and fuel required by the railways, does extend itself to all materials used for the telegraph service.

From the 1st May, 1879, the extension of the pneumatic lines has allowed of organising a new system of special pneumatic telegrams (telegraph cards and sealed telegrams).

The price of these, with an unlimited number of words, was originally fixed at 50 centimes for the telegraph cards, and at 75 centimes for the sealed telegrams.

On the 5th April, 1880, we granted further advantages to the public, by creating the telegraph card with prepaid reply. The price of these was fixed at 1 franc. Finally, on the 1st June, 1880, the price of sealed telegrams was reduced to 50 centimes, that of telegraph cards with prepaid reply, to 60 centimes, and that of simple telegraph cards at 30 centimes.

Thus, at a cost of 30 centimes (three pence), a telegraph card can be obtained, one side of which is reserved for the address and the other for the message. This card, handed in at one of the

SPECIAL TELEGRAMS.

YEARS.	Telegraph Cards.		Sealed Telegrams.		Total of Special Telegrams.		Grand Total of Telegrams—Paris to Paris.	
	Number.	Produce. Francs.	Number.	Produce. Francs.	Number.	Produce. Francs.	Number.	Produce. Francs.
1877	...	...	...	...	...	...	393,324	286,848
1878	...	...	...	...	...	...	522,603	395,640
1879 { From the 1st May till the 31st December for special telegrams . }	114,508	57,254	29,885	22,414	144,393	79,668	637,282	455,465
1880	334,445	120,529	123,800	68,921	458,245	189,450	969,177	579,910
1881	619,418	186,347	335,108	167,554	954,526	353,901	1,510,037	778,063
1882	846,611	254,821	515,503	257,751	1,362,114	512,572	1,850,443	882,877
1883	1,175,971	353,875	713,633	356,817	1,889,550	710,692	2,237,488	969,947
	841,472	233,346	589,833	287,896	1,431,305	521,242	1,844,164	683,099
	Increase during 1883, *as compared with* 1880, *the first year of the complete working of special telegrams.*						*Increase during* 1883 *as compared with* 1877.	
Or	221 per cent.	178 per cent.	476 per cent.	418 per cent.	312 pr. cent	274 pr. cent	469 per cent.	238 per cent.

offices in Paris, is immediately forwarded by way of the pneumatic tubes to the office of destination, and delivered at the address, within a delay averaging from 30 to 45 minutes.

Owing to the credit granted by the Chambers, and which has been distributed over a period of four years, all the offices in Paris will be connected by the pneumatic tubes at the end of 1884; the advantages of this special service will thus be extended to the whole of the present precincts of Paris.

The important results obtained by the extension of the pneumatic system and the creation of special telegrams is shown by the preceding table.

The number of special telegrams, therefore, has increased fourfold from 1880 till 1883, and the grand total of telegrams from Paris to Paris nearly has augmented six-fold from 1877 till 1883.

The number of special telegrams continues improving. During the first quarter of 1884 it amounted to 588,884, or an increase of 30 per cent. as compared with the corresponding period for 1883.

To obtain the total traffic of Paris, we have to add to these figures the inland and foreign messages to and from Paris, as well as those for which Paris is neither the office of origin or destination, and which merely pass through the central telegraph office.

The following tables show the importance of this total traffic, and the produce of the telegraph receipts in Paris.

TELEGRAPH TRAFFIC OF PARIS.

YEARS.	Forwarded Telegrams.				Received Telegrams.				Transit Telegrams.		
	To Paris.	To The Country.	To Abroad.	Total.	From Paris.	From The Country.	From Abroad.	Total.	Central Station.	Stock Exchange.	Total.
1877	393,324	1,715,362		2,108,686	393,324	1,609,930		2,003,254	5,300,700	1,128,719	6,429,419
1878	526,603	2,429,342		2,955,945	526,603	2,287,518		2,814,121	7,136,500	1,654,663	8,791,163
1879	637,282	2,152,705	653,915	3,443,902	637,282	2,168,370	550,411	3,356,063	8,770,800	1,481,884	10,252,684
1880	969,177	2,718,918	886,470	4,574,565	969,177	2,667,506	690,033	4,326,716	11,559,200	2,099,369	13,658,569
1881	1,510,037	3,237,826	1,161,732	5,909,595	1,510,037	3,282,461	835,815	5,628,313	13,944,291	2,088,301	16,932,592
1882	1,850,443	3,152,494	1,052,196	6,055,133	1,850,443	3,214,256	670,407	5,735,104	13,474,813	2,289,283	15,764,096
1883	2,237,488	3,063,121	1,060,741	6,361,350	2,237,448	3,225,750	632,070	6,095,308	13,657,131	1,442,461	15,099,592

The total traffic in 1877, therefore, amounted to 10,148,035 messages, and in 1883 to 25,318,762; it has thus more than doubled itself.

TELEGRAPH RECEIPTS OF PARIS.

YEARS.	Produce of the Telegrams.			Grand Total of Receipts.
	Paris to Paris. Francs.	Paris to the Country. Francs.	Paris to Abroad. Francs.	Francs.
1877	286,848	2,159,011	4,351,696	6,797,555
1878	395,640	2,339,817	4,865,364	7,600,821
1879	455,465	2,310,469	4,857,081	7,723,015
1880	579,910	2,941,748	5,925,708	9,447,366
1881	778,063	3,492,273	7,126,376	11,396,712
1882	882,877	3,289,326	6,268,187	10,442,390
1883	969,946	3,138,116	6,341,753	10,449,815

The telegraph receipts of Paris, which in 1877 were 6,797,555 francs, amounted in 1883 to 10,449,815 francs, or an increase of 3,652,260, equal to 53 per cent., notwithstanding the numerous reductions in the telegraph rates, and more particularly the enormous falling off in receipts for ordinary telegrams, owing to the adoption of telegraph cards and sealed telegrams.

We have been obliged to state more circumstantially the details of the central post office of La Seine, the central telegraph station, and the central telegraph office of the stock exchange, because of their work being much more extensive and complicated. The rules are general and uniform; but these offices, of course, allow of applying them under other conditions than the offices of little importance.

As mentioned before, there are at present opened to the public 84 post offices and 92 telegraph offices.

On the 1st January, 1878, the number of post offices in Paris was 61, and that of the telegraph offices 57.

Besides, the three simple post offices which existed still in Paris in 1877, have been converted into post and telegraph offices. In the amalgamated offices the hours of opening and closing for postal work and for telegraph work have been assimilated.

The premises in which the post and telegraph offices in Paris are installed have been improved. New "guichets" have been opened in the greater part of these offices, and postal "guichets" have been placed in the telegraph offices.

The combined services of posts and telegraphs in the Department of Paris and La Seine employed, in 1883, 6,830 clerks, carriers, postmen, and messengers, against 3,681 in 1877, showing an increase of 3,149, or 86 per cent.

In order to forward the quick delivery of telegrams in Paris, boys from 12 to 14 years have been substituted for grown-up messengers; they are paid in proportion to the number of telegrams delivered by each of them.

Very satisfactory results have been obtained by this, and it has allowed of reducing, by nearly one-half, the number of grown-up messengers. We only required to increase the number of the chief-messengers, because of the supervision that has to be kept over these boys; this number now amounts to 59.

Before entering the service of the Administration the boys must prove that they have complied with the rules of the law on compulsory education. Even after their admittance we see that they follow some courses, to complete their education. Other privileges are reserved to them when they have completed their fifteenth year.

(To be continued.)

NEW PATENTS—1884.

11709. "Electric clock." T. CALLIPHRONAS. Dated August 27.

11715. "Electrical signalling and apparatus therefor, chiefly for telephonic systems." W. R. LAKE. (Communicated by Equitable Electric Company.) Dated August 27. (*Complete.*)

11733. "Laying underground conducting wires for electrical purposes." B. P. STOCKMAN. Dated August 28.

11736. "Plates for secondary batteries." W. WILKINSON. Dated August 28.

11737. "Galvanic chains or belts for curative purposes." H. J. HADDAN. (Communicated by W. Donnerstag.) Dated August 28.

11738. "Storage batteries." H. EDMUNDS. Dated August 28.

11747. "Electric signalling letter box." W. J. BAKER. Dated August 28.

11786. "Galvanic batteries." B. A. SLADE. (Communicated by C. E. O'Keenan.) Dated August 30.

11841. "System for the carrying or conveyance of telegraphic, telephonic, or electric light wires." H. H. MARTYN. Dated September 1.

11843. "Method of working telephonic exchanges and apparatus connected therewith." L. J. CROSSLEY, J. F. HARRISON, W. EMMOTT. Dated September 1.

11853. "Secondary batteries." E. G. DORNBUSCH. Dated September 1.

11864. "Steam motive power apparatus on shipboard for driving electric generators, &c." J. WEIR. Dated September 2.

11876. "Boxes or cells for primary or secondary batteries." F. G. HOWARD. Dated September 2.

11892. "Galvanic batteries." J. B. SPENCE, H. A. FERGUSSON. Dated September 2.

11894. "Insulating electric conductors and controlling induced currents therein." A. W. L. REDDIE. (Communicated by E. D. McCracken. Dated September 2. (*Complete.*)

11902. "Charging and discharging primary and secondary batteries." M. Sugar. Dated September 2.

11903. "Dynamo-electric machines." W. B. Smit, A. Pot. Dated September 2.

11904. "Electric arc regulator lamps." F. C. Phillips. Dated September 2.

11908. "Electric torch." O. Imray. (Communicated by E. Arnould.) Dated September 2.

11912. "Telegraphic apparatus." R. K. Boyle. Dated September 2.

11914. "Electro mechanical signalling apparatus and the system therefor." M. Toulmin. Dated September 2. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

6425. "A new or improved electric battery." W. A. Barlow. (Communicated from abroad by C. Gauzentès, of Paris.) Dated April 16. 6d. The elements of the new battery are composed of two boards, between which are arranged a certain number of sheets of zinc; between each of these sheets are arranged a certain number of carbon plates. The two boards are pierced with holes in which the extremities of the zincs are engaged. The zincs extend beyond and below one of the two boards, and are connected electrically by a thick rod of metal which traverses through the extending portions of the zinc. One terminal is screwed to the central sheet of the set, and is thus in communication with all the others. The carbons are pierced with two holes. To construct the battery there is first placed in position the zincs, and then, by means of short lengths of wood rods, the carbons are separated therefrom. The carbons are held apart by blocks of carbon. The carbons are put in connection by metal wires, for which purpose the wires are passed through the holes in the carbons and in slots made in the small carbons. This connection is effected under one of the two boards in which small holes are made through which pass the wires of all the groups, and these are connected to the other terminal. To avoid the wires being in contact with the zinc, or with the wire connections thereof, and for holding all the parts of the group or element of the battery in place, the whole is cemented or fixed solidly on the plate by means of an agglomerate substance, which is also insulating. To ensure perfect contacts, all the connecting wires of the battery are covered with a layer of paste of finely divided carbon mixed with water, forming thus around the wires and the connections a good conducting mastic. For securing the proper working of the apparatus, the plate receives a layer or insulating covering, which will cover all except the terminals, the connecting wires being thus completely insulated; thus perfect contact is secured without fear of oxidation of the metal.

7347. "Improvements in telephone transmitters." W. R. Lake. (Communicated from abroad by H. Clay, of America.) Dated May 6. 6d. Relates to the apparatus described in the number of the Review for August 2nd, 1884.

7444. "Improvements in electrical apparatus for lighting gas or other lamps, or the like." J. H. Johnson. (Communicated from abroad by W. Deckert and E. Homolka, of Vienna.) Dated May 8. 6d. Consists of a metallic igniting tube, provided at its upper end with a stopper of hard India rubber or equivalent material, in which conducting wires are secured, the outer ends of which are connected by a piece or spiral of platinum to be rendered incandescent when a current of electricity passes therethrough. The electrical accumulator consists of a cylinder or vessel preferably of hard India rubber, in the interior of which is arranged suitably prepared lead plates and an electrolyte, which is introduced into the cylinder by means of a tube or passage in the cylinder, closed by a cap, preferably of India rubber, so as to provide an expander for the accommodation of any gases which generate in the accumulator. The bottom of the cylinder may be protected by a metal covering.

9104. "Couplings for metal-cased insulated electric conductors." J. S. Raworth. Dated June 17. 6d. Relates to couplings by which separate lengths of casing tubes are securely connected, the ends of the conductors themselves being at the same time brought into certain contact so as to ensure maintenance of the circuit. For connecting two lengths of cased conductor in one line, the inventors screw on to the end of each tube a thimble having a conical collar, behind which there is a screwed sleeve like that used for an ordinary pipe union. On front of the thimble is a filling piece, which may be of wood, containing in a conical recess a piece of insulating material through which the end of the conducting wire projects. The projecting end of the wire is coiled into a flat convolution, the face of which is scraped bright. The inventors then bring the two wire convolutions together face to face within an internally screwed socket, into which they screw the two sleeves. These, bearing against the collars of the thimbles, press the wire convolutions firmly together, so that they make sound electrical contact, whilst, at the same time, the two lengths of casing tube are firmly united by the hold which the sleeves upon them take in the socket.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

CORRESPONDENCE.

The Late Vienna Electrical Exhibition.

I should be pleased if any of your readers could give me some information respecting the awards of the Scientific Commission at the above exhibition.

I was an exhibitor there, and sent in a written request to the commissioners to make an official inspection of my goods. I was informed, after I had left, by the secretary to the British Commission that the inspection had taken place, and that I should receive the report in due course. I have not, however, heard a single word from anybody; and if exhibitors are to be treated in this fashion, after spending large sums of money to make their stands attractive, the sooner they give up all thoughts of continental exhibitions the better.

Your readers are perhaps not aware that no prizes were offered at the Vienna Exhibition; the commission being of opinion that authentic reports would be of much more value to the various exhibitors. I think that it is the duty of the British representatives to see that full justice is done to everybody concerned.

S. B.

Electro-motors.

In your article on the above subject in the issue on 23rd August of the Electrical Review you refer to the want that has been felt for an efficient battery requiring no attention.

It may be interesting to your readers to know that in a short time we shall bring before their notice a new battery, which will fulfil these stipulated conditions. Meanwhile we may mention that the new element in the battery is our "silico carbon," patented in February last. This we can manufacture in very large solid plates.

The batteries do not require any attention, and are worked without acids, lasting for a "moderate period."

We have not yet been able to stock any such batteries, but have one of nine elements driving a dental motor at our place, 23 and 24, Grafton Street East, W.C., which may be seen at any time during business hours.

Coxeter & Nehmer.

23 and 24, Grafton Street East,
London, W.C., *August 30th*, 1884.

The Late Mr. Volckmar.

Under the above heading, in your issue of August 30th, the Electrical Storage Company, Limited, have taken the opportunity of stating that they own the patent of Faure, Swan, Sellon, and Volckmar, and through ignorance, or otherwise, assert that these patents constitute "the combination covering the whole ground of electrical accumulators." It is also asserted "that the Faure patent without the Sellon-Volckmar is impracticable, and that its entire value is given to it by such combinations." So far as those knowing the subject are concerned these statements might be left unanswered; but as the question is one of no small importance to users and the world at large, in view of what must be the future demand and use of electric accumulators, it seems necessary to question the truth of these statements, and especially as to the pretentions and unwarranted claims as to the monopoly of the above-named company to supply a practical accumulator in view of facts to the contrary; and in face of the fact that there exist accumulators not owned by this company, whose efficiency and practicability is much superior to theirs, without in any way coming within the limits of their non-monopolising claims.

Dan. Boyd.

76a, Mosley Street, Manchester,
September 2nd, 1884.

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